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We review existing research, select a re-engineering methodology, develop an implementation strategy and then perform a 'case study' examination of this methodology and strategy. For the case study, we take a legacy system, the Navy satellite communications multiplexer, the TD1271B/U Multiplexer, examine its existing documentation, develop a code analysis tool, perform the re-engineering on one of its sub-systems, and analyze the results. We provide observations, recommendations and conclusions on changes, enhancements and pitfalls to the methodology that will be of assistance in future re-engineering efforts of legacy systems.

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RE-ENGINEERING OF A MISSION CRITICAL SATELLITE COMMUNICATIONS COMPONENT TD1271B/U

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Submitted in partial fulfillment
of the requirements for the degree of

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from the

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Legacy software in general, and in the DoD environment in particular, presents an ever-growing maintenance challenge to program managers. The software is cumbersome, written in arcane languages and hosted on aging technology hardware. One of the options that is available to the program manager to alleviate this problem is to re-engineer the existing software product and update it to a newer language software hosted on modern equipment.

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I. INTRODUCTION

A. BACKGROUND

One of the more complex issues associated with a software organization of significant size is the existence of large amounts of legacy software. This software typically was developed years ago, modified extensively by a variety of programmers, and is currently operating on obsolete systems hardware. The programmers that worked on the various modifications have moved on to new projects or left the organization entirely. In most instances, limited or no documentation updates have occurred. These factors all build upon each other until the software is no longer supportable. The hardware is typically old and all of the original processor reserve has been consumed, making the hardware as unsupportable as the legacy software that runs on it. The overall system is so bad that it has but one single saving grace. It works.

The program manager is charged with the responsibility of continuing to provide the services of the program while watching his ability to support the program fading. This leaves the program manager few options.

One option is to live with the system as it exists and continue to 'Band-Aid' any problems as best one can. This tends to be an expedient answer early in the life of the program, but sooner or later, this will no longer be a viable option. At some point in time the program manager will not be able to continue to support this legacy code due to physical constraints or expense.

A second option is to completely replace the existing system. This involves reviewing the current program requirements and documentation, as well as the organization operations and goals, and then to factor in those enhancements that may have forced this change in the first place. Based upon this review, a new set of requirements are generated. From these new program requirements, the program manager will need to select hardware, programming language(s), design architecture, and finally implement the software. This is then followed by a training curve to allow the operator to learn the new system. This approach has several drawbacks. The first is

usually a lack of current documentation to start the review from. It is commonplace for organizations to try to limit their maintenance costs at the expense of the quality documentation updates. Another problem are the 'hidden' enhancements; functions that are routinely use by operators, but are not documented as requirements or options even in well maintained documentation. A third is the amount of time needed to implement a full development. And, of course, there is the cost. Often for large systems the costs of a full development run hundreds of thousands of dollars, and it is not unknown for a single program's development to cost millions of dollars.

A third option is to scrap everything except for the working code and perform an in-depth analysis on the code to extract the requirements. This will tell the analyst what the code is actually doing. To this must be added the additional requirements not currently implemented. The state of the legacy code can be a drawback to this method. The success of this method is dependent upon the standards and practices used while maintaining the code. If the code was maintained by a series of programmers, each with their own standards and practices, the analyst may find extracting the information to be quite a challenge and extremely time consuming.

The fourth option is a combination of the last two, extracting the best features of each of the two options to limit the cost and time associated with updating the system. This is implemented by performing a code review and using the existing documentation as a guide to the software's basic architecture. This combination of methods reduces the amount of time required to perform the code analysis, while providing a quality requirements trace.

Each of these options has it's own advantages and drawbacks. Early in the life cycle of a software system it is fairly inexpensive to correct and fix an immediate problem. As more changes are made it becomes more expensive to correct defects or make changes. It is estimated that in a large data processing shop, 70 to 80 percent of the budget is consumed by maintenance of legacy programs [40]. Eventually the legacy system will need to be modernized.

When planning the modernization of a computerized information processing system, there are two basic items to consider: the hardware and the software that comprise the system. In the normal course of events finding a new target platform is the easier process. The speed, power, and memory capacities of computer hardware have been increasing; while hardware size and costs have been steadily falling. Replacing the software itself is another question. As the costs of hardware have fallen, the costs of software development have been rising.

This contrast of costs, cheap hardware and expensive software development, leads the program manager to look at ways of lowering the cost of the software while updating the hardware platform. The first approach would be to take the working software and port it to a new, more powerful platform. This can be done in limited circumstances, but he will normally be restricted to remaining within the existing family of processors (i.e. going from a Motorola 68030 to a Motorola 68040). In the general case, he will run into the problem of incompatibility. The existing legacy software will not run on the processor in the new platform. This places the program manager at the crossroads noted above: which of the four options is best for the project?

In this thesis we will examine the 'option four' method of modernization, that of utilizing both the existing code and documentation to develop a new baseline program hosted on a more modern hardware platform; the process of Re-Engineering.

B. RE-ENGINEERING

There are several definitions for re-engineering in the literature today [41] as described in the following:

- "Software reengineering is any activity that (1) improves one's understanding of software, or (2) prepares or improves the software itself, usually of increased maintainability, reusability, or evolvability".
- "The process of modifying the internal mechanisms of a system or program the data structures of a system or program without changing its functionality."

- "The examination and alteration of a subject system to reconstitute it in a new form and subsequent implementations of that form."
- "Re-engineering changes the underlying technology of a system without affecting the overall function, while reverse engineering is the backward engineering of a system to the specification stage. ... Re-engineering ... is the first step toward reverse engineering"

As can be seen from these quotes, the terminology of the process is not clearly defined. Some believe that Re-engineering is the beginning of the Reverse Engineering process, other that Reverse Engineering is the beginning of the Re-engineering process. For our purpose within this thesis, we will look upon reverse engineering as the systematic review and analysis of existing code to establish an information base from which to re-implement the system i.e., the first step in the re-engineering process.

Even within these somewhat conflicting terms, there are levels of re-engineering. If the only requirement is to "copy" the existing system onto a new platform, it will only be necessary to extract the architecture from the existing code and documentation before you can re-implement the same architecture in a new environment. If you want to update the architecture, then you will need to extract up to the design level before re-coding can start. Depending on the level of re-design you wish to implement you will need to extract to one level higher to allow a baseline for forward engineering at the level you want to implement.

C. OUR THESIS

For our thesis we selected a re-engineering methodology from existing research that we thought had the best application to legacy systems. We then examined this methodology of re-engineering by performing a case study. We took a legacy system, examined the existing documentation, performed the re-engineering on one of it's sub-systems and then analyzed the results. Based on this analysis and other observations we will recommend modifications to the methodology that will assist in future re-engineering

efforts. Our legacy code for this procedure is a Navy satellite communications multiplexer: the TD1271B/U Multiplexer.

II. TD1271B/U MULTIPLEXER

A. BACKGROUND

Until the space age, the high frequency (HF) spectrum was the only means of passing messages over long distances by radio. Although other frequency spectrum radios were available, their characteristics limited their use to 'line-of-sight' operations or limited data rates. With the space age came the ability to place an Ultra High Frequency (UHF) radio repeater in a geosynchronous orbit. By placing a transmitting station high above the earth, it's 'line-of-sight' earth coverage was greatly expanded. The characteristics of the UHF Satellite Communications lended itself well to the needs of the Navy. It provided dependable over-the-horizon communications capability at accelerated data rates. The high data rates allow the transfer of data and voice. As the capabilities became more developed and terminals became more prolific, time lags and data delays became more regular. System throughput began to suffer. This left the Navy with a limited number of options. One was to reduce the number of users and the amount of data they were sending. This was an extremely unpopular option to the Fleet. They had grown to depend on the types and levels of data being supplied, and their effectiveness would suffer if any of the data were discontinued. The second option was to acquire more UHF channels. This was not a viable option either. The commercial world was rapidly expanding into the UHF spectrum, and lobbying congress to decrease the number of channels reserved for military use and sell them to commercial interests. The only option left was to find ways to utilize the existing channels more efficiently. To meet the need for more efficient usage of the UHF channels the Navy developed the TD-1271B/U Multiplexer.

The basic philosophy behind the TD1271B/U Multiplexer, or MUX, is to use Timed Division Multiple Access (TDMA) principals to integrated multiple nets, each operating on an independent channel, onto a single channel. By multiplexing several channels onto a single channel more data transmission path options become available.

B. TIME DEVISION MULTIPLE ACCESS (TDMA)

In TDMA, data streams at moderate to slow data rates are input via baseband data ports and buffered. At a point in time, predefined for each data port relative to a time marker, this data is transmitted out at a data rate that is significantly faster that the input data rates. While one baseband port's data is being burst out to the satellite, the other ports data streams are being buffered, awaiting their burst opportunity. Using appropriate bursting speeds, none of the baseband units will suffer any loss of continuity in their data. Each will transmit and receive data just as if on a dedicated channel, without realizing the data was multiplexed. This concept is illustrated in Figure 2-1. The key to this process is being able to transmit at a faster data rate than all of the baseband ports data rates combined. The elapse time between the start of one timing mark and the beginning of the next timing mark is generally referred to as a frame. The period of time allocated for a transmission burst is often referred to as a time slot. Depending on the particular protocol for the system, the TDMA Frame may contain a series of time slots with equal time periods or may have time slots with varying time periods.

C. TD1271B/U MULTIPLEXER

In the TD1271B/U Multiplexer (MUX) operating in the TDMA-1 25 kHz mode, a frame is defined as a period of time equaling 1.38666 seconds.[1] This frame not only has varying time slot periods, but is re-configurable based on users needs. The allocation of time slots is determined by the definition of a three digit (hex) Frame Format code. Each of the digits defines the configuration of one of the three user segments contained in the frame. A typical MUX frame is diagrammed in Figure 2-2.

The MUX waveform accommodates multiple input/output (I/O) bit rates and radio frequency (RF) symbol burst rates, as well as dynamic assignment of users between channels. Operation of the MUX waveform is transparent to the user baseband equipment, except for TDMA frame-time delays.

---

[1] The TD1271 MUX is also capable of a secondary waveform (TDMA-2 or TDMA-3) that utilizes a 5kHz channel. Discussion of this 5 kHz waveform is beyond the scope of this thesis.

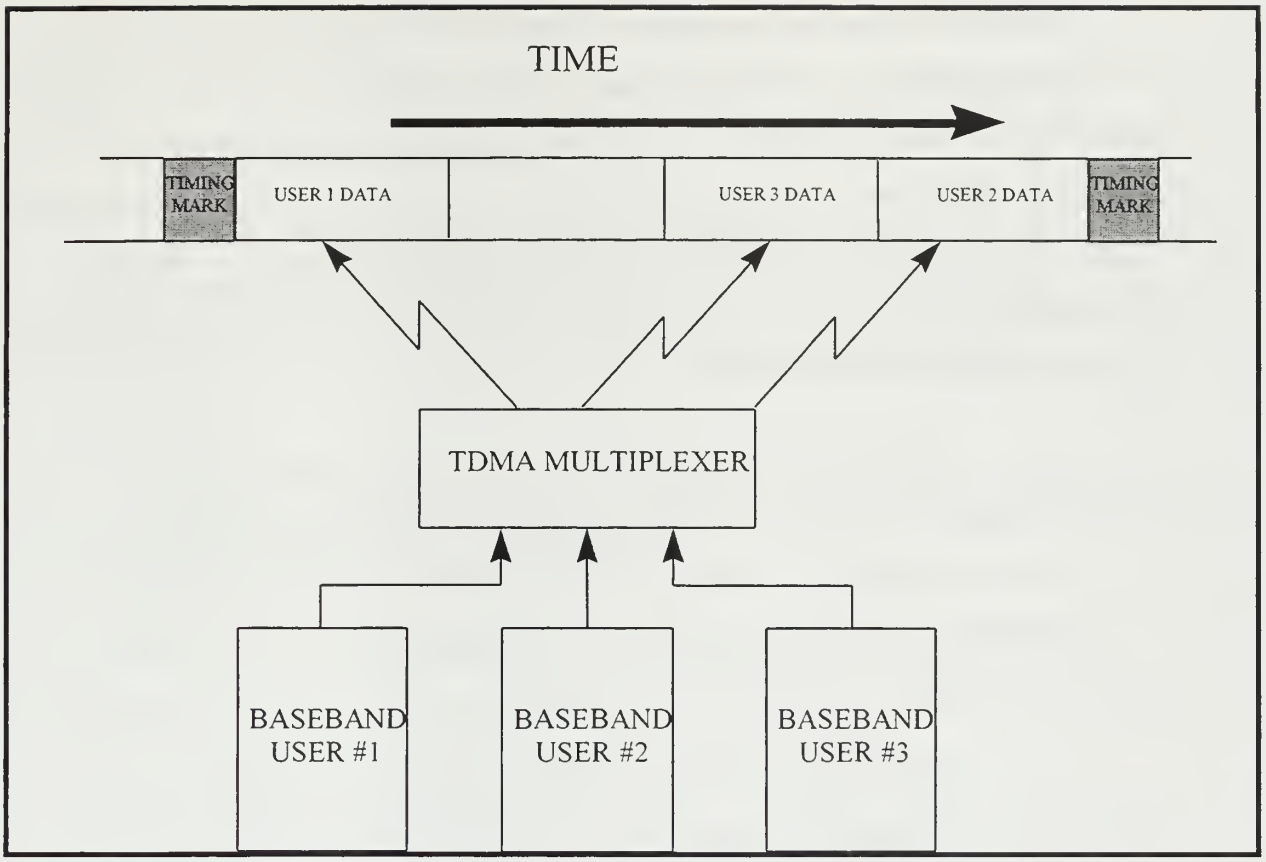

Figure 2-1
Time Division Multiplexing

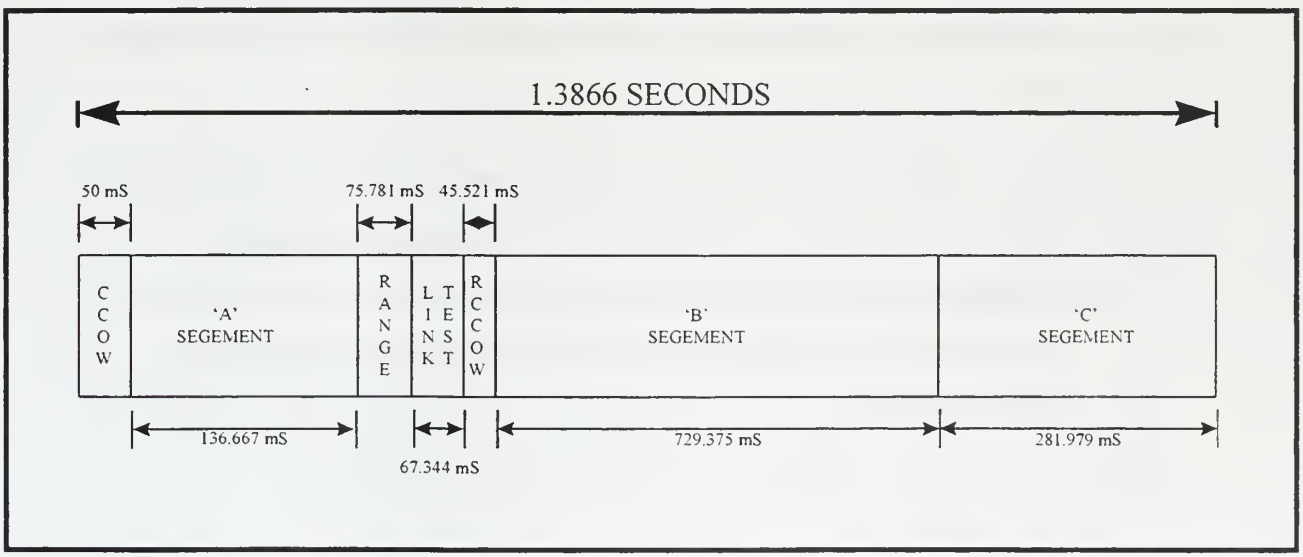

Figure 2-2
Typical TD1271B/U Frame Configuration

The MUX waveform is organized as a repetitive frame structure with 1.386-second frames, as depicted in Figure 2-2 (Frame Type 2 is depicted[2]). Frames are subdivided into slots assigned for: (a) orderwire communications [channel control orderwire (CCOW) and return channel control orderwire (RCCOW)]; (b) system support functions (range time slot and link-test time slot); and (c) user segments A, B, and C. User segments A, B, and C comprise multiple user slots. Each of the 5 slot types in the MUX waveform is identified below:

1. CCOW slot. The CCOW slot is used by the channel controller to broadcast CCOWs. One of the 20 defined CCOWs is transmitted by the Channel Controller in each frame. The CCOW contains the information required to control operation of the waveform and provides a timing mark for the frame.

2. RCCOW slot. The RCCOW slot provides users the opportunity to send data, including requests for access, to the channel controller.

3. Range slot. The range slot provides time for users (including the channel controller) to transmit and receive a data burst for the purpose of calculating the range to the satellite, based on measured round-trip delay time.

4. Link test slot. The link test slot provides time for users (including the channel controller) to transmit and receive a test data stream to determine the current operating conditions, based on the measured bit error ratio (BER). The link test slot is also used to perform dedicated range measurements, when the link test slot is in an even-numbered receive frame. This is known as an even link test (ELT) slot.

---

[2] In order to support half duplex terminals, the MUX waveform supports a Frame Type 1 that moves the 'C' segment slots between two halves of the 'B' segment. The half duplex network would transmit in the first 'B' segment and receive in the second 'B' segment.

5. User slot. User slots are allocated for transferring data between users. Associated with each user slot is a specific baseband data rate, encoding schema, and burst rate.

Each slot within the MUX waveform consists of three elements: (1) a preamble for receiver carrier, bit, and data synchronization; (2) data; and (3) guard time to avoid user-to-user interference. The receiving equipment achieves carrier and bit synchronization for each slot in the waveform.

The MUX waveform is designed to operate on 25-kHz non-processed channels of current and planned UHF SATCOM satellites.

The MUX accepts input from digital communications systems via it's four baseband data ports. The baseband data ports will accept data at rates of 75, 300, 600, 1200, 2400, 4800, and 16000 bits per second. In order to maintain data integrity, Forward Error Correction (FEC) encoding is used. This FEC coding is convolutional, with interleaving. Encoding rates of ½ or ¾ are used. The MUX will output the data to the radio for transmission at one of three burst rates; 9,600, 19,200 or 32,000 symbols per second. The interface between the radios and the MUX is over 70 MHz intermediate frequency carrier lines. Reception of data is processed in a similar, but reversed, fashion.

One of the most critical functions of the MUX in this process is to maintain consistent timing within the frame. This timing begins with the reception of the timing mark to begin the frame. In the MUX system, all timing is based on the reception of the Channel Control OrderWire (CCOW). The primary CCOW is the Master Frame CCOW and contains the current frame format number, frame sequence number, and cryptographic data needed to define operations on this channel. The Master Frame is transmitted every eight frames. Other CCOWs are available to direct net operations, request data from the various terminals[3] operating on the net and maintain timing.

[3] Although we are only concerned with software and hardware of the TD1271B/U, there are other terminals that are operating on nets with the TD1271B/U. When discussing operations in general, we will use the term terminal to include all of the possible systems operating on a channel.

CCOWs are generated and broadcast by a specifically designated terminal. Each channel will only have a single terminal generating CCOWs at a time (the Primary Channel Controller (PCC)) although other stations could be designated as alternate controllers (ACC).

Once the MUX has successfully received the CCOW, the next critical event is to calculate the terminals distance to the satellite in units of time. The standard time unit in the MUX is the 'time chip'. There are 19,200 time chips in one second. In order for all terminals on the net to receive data in the proper locations within the frame, all transmissions are timed to be correctly placed within the frame at the satellite. In order to insure this 'perfect' frame at the satellite, and by extension at each receiving terminal, the distance to the satellite must be known. This is achieved first at power-up by sending a ranging burst during the designated ranging slot, and updated periodically using the Even Link Test (ELT) slots.

D. TD-1271B/U MULTIPLEXER DESIGN

The basic TD-1271B/U installation comprises a TD-1271B/U multiplexer, a KGV-11 encryption device, a radio transceiver (a Navy WSC-3 pair is typical) and from one to four baseband user devices (ANDVT, ON-143 or teletypewriters would be typical). Figure 2-3 provides a block diagram of a basic TD-1271B/U's configuration.

The software in the MUX is divided into three Computer Software Configuration Items (CSCI); the System Control Processor (SCP), the System Timing Processor(STP) and the Data Buffer Processor (DBP).

Each CSCI has a Memory Program Unit (MPU), an interface board, and at least one 24 k byte Ultra Violet Erasable/Programmable Read Only Memory (UVEPROM) board that contains the executable program. The SCP CSCI utilizes two UVEPROM boards.

The Memory Program Unit (MPU), hosts the Central Processor Unit (CPU), a Motorola 6800, along with the System Random Access Memory.

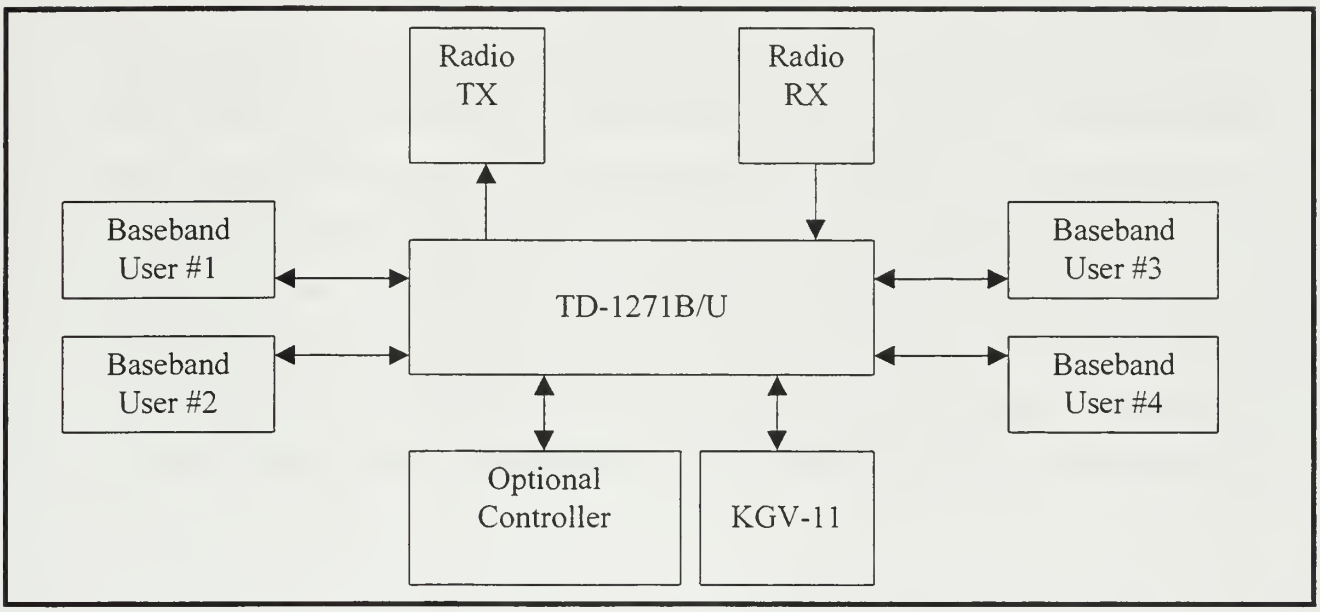

Figure 2-3
A Basic TD-1271B/U Configuration

III. THE RE-ENGINEERING PROCESS

A. PROCESS PHASES

Re-engineering begins with the assembly of all resources of a software system. This includes, but is not limited to the software source code, design documents, software development folders, test reports, software trouble reports, sample inputs, sample outputs, and, if practical, interviews of the implementers and/or maintainers. Typically the only reliable source of information is the software source code and for that reason re-engineering of an existing software system starts at the code level. The software documentation, many times, are not kept current with the software; however, it can still be a useful source of information and can be used as an engineering guide. The process in which existing software is transformed into a new implementation can be described in the Figure 3-1 [30].

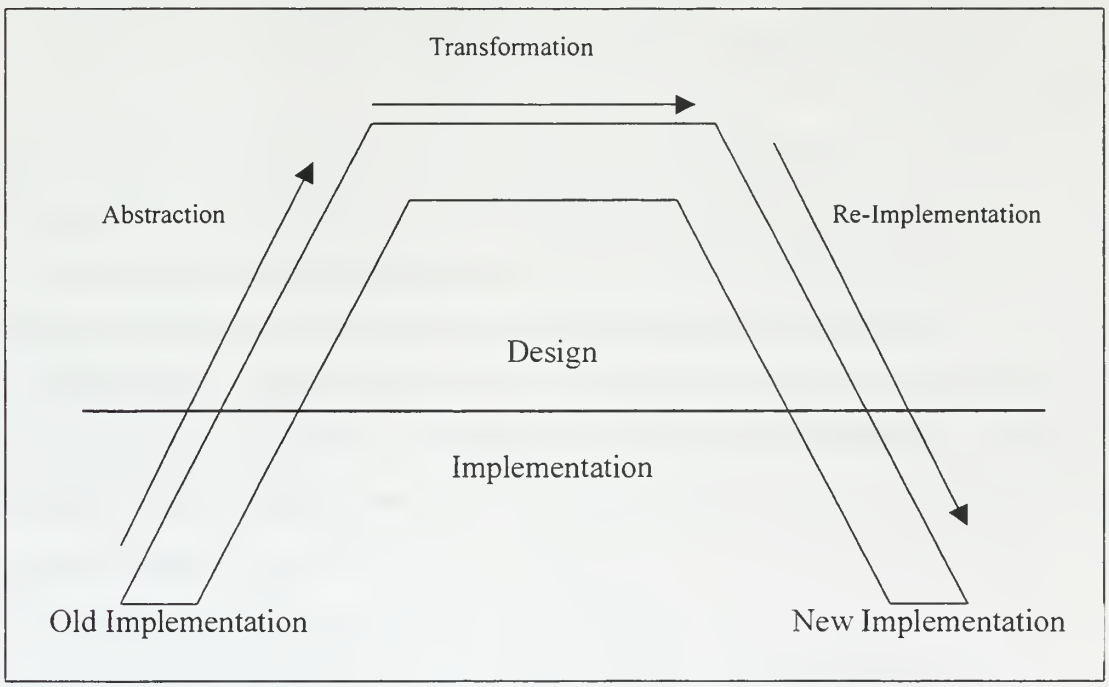

Figure 3-1
The Re-Engineering And Implementation Process

There are three phases to the re-engineering process. The first phase, abstraction, extracts the detailed design information from the documentation and the code. For those familiar with MIL-STD-498, this is analogous to creating a Software Design Document from the existing system. The second phase allows for the modification of the design by adding, deleting, or modifying requirements. The third phase is a re-implementation of the system. The focus of this thesis is the reverse engineering process that recovers the design from the old implementation. This methodology will be validated by executing the re-implementation of the recovered design using a different language and different processor than the old implementation.

1. Phase One: Abstraction

In this phase, the documentation and code can be used to provide the information needed to support the re-creation of the system design. Since the TD-1271 documentation has been shown to be unreliable, the source code will take precedence in this phase with the documentation providing background information. The products developed during abstraction are as follows [30]:

1. Structure Chart. This is a hierarchy of the modules as extracted from the program where each node in the chart corresponds to a procedure or function in the program. Since the goal of abstraction is to remove the language dependencies from the code, it is important to treat library calls as part of the system and include them in the structure chart. The language selected for the re-implementation phase may not provide the same library services. Any language dependent library calls may need to be manually re-implemented. The structure charts for this thesis are based upon the structure charts identified in reference [37]. The structure charts provide a visual representation of the software system that is useful in determining organization and dependencies. This information, once derived, is used to develop the structure charts for the enhanced system.

2. Module Description. This description is a combination of the module's inputs, processing, and outputs, with the algorithms and constraints identified. This description is produced for each module in the structure chart. In addition to a narrative of the module's processing, a language independent form using a specification language such as SPEC [42] or a Program Design Language (PDL) is used to capture the requirements of the module. For this documentation to be useful it is important to verify, through code reading, that the supporting documentation is up-to-date. A case tool that allows this information to be tagged to each element in a structure chart would be very helpful. One of the original goals was to identify a tool to preserve this information as part of this thesis, but due to budgetary considerations no tool was procured.

3. Data Flow Diagram. At a module level the data flow diagram shows the flow of data between the modules. Within the module that the data flow diagram is decomposed, showing at each successive decomposition level the transformations that occur. This information is also used to develop the algorithms that need to be documented when the design is re-implemented. These algorithms can be described using mathematical notation, a Program Design Language, or other notation. These algorithm descriptions are added to the module description in step 2. The process consists of constructing the DFD of level i+1 from level i. Each level explodes the data into transforms, data repositories, and data flows [37]. Data repositories will be represented as boxes, data transforms as circles, and data flows as connecting lines between transforms and data repositories. The transforms are then used in phase 2 to develop the detailed design.

4. Control Flow Diagram. This will identify the control structure of the program between the modules. This information is used to identify the logical relationships between the modules, verses the physical relationship described in step 1. [39] will be used to create this diagram.

5. State Transition Diagram. This will identify the states and modes in which the software can reside and identify the events that cause a change in the state of the software and the processing that is to occur due to the state change, and will identify the modules active for each state. There may be more than one state transition diagram depending upon the concurrency of the system. The notation for this diagram will follow those in [39].

Once the design information has been extracted, the resulting recovered design is reviewed for consistency. Any missing items of information should be investigated and added to the recovered design [30]. While it is the goal of this first phase to extract the design and leave behind the vestiges of the language and platform, the design may still have an organizational structure that was due to the implementation language and platform. Before entering phase two, the extracted design information can be modified to refine the design for portability. For example, the TD1271B/U uses multiprocessors with serial communications between them to perform the processing required. When the system is re-engineered, it is anticipated that this system will be implemented using Ada tasking on a single microprocessor. The detailed design should be abstract enough to make this possible.

2. Phase Two

Phase one used the supporting documents and the code to extract the detailed design information. This phase attempts to link the detailed design information with the requirements through the use of a requirements traceability table. This table binds the modules with the requirements that they partially or fully implement. This table will need to support one to many and many to one. That is, one requirement may be spread out over one or more modules and many requirements may be identified with one module. Depending upon the state of the supporting documentation this can be an easy task or a major effort. Requirements are needed if the system being reengineered is also having the requirements modified as well. Once the requirements have been modified, the modules affected need to be updated. It is not unusual at this phase to add and delete

modules from phase one. This phase is identified for completeness only; this thesis will not attempt to construct a requirements traceability table.

The TD1271B/U was developed under DOD-STD-1679 and any re-engineering of the TD1271B/U would use a tailored MIL-STD-498 approach. The purpose of the re-engineering effort is to develop, using the existing resources of the project, those products necessary to pass the exit criteria of the detailed design phase and allow the system to be coded. The primary product that is developed during the detailed design phase is the Software Design Document. When looking at the data item description (DID) the following sections are used to provide the programmer with the information necessary to code the system. From the re-engineering activities performed on the TD1271B/U in the three phases described above, the following module information will be developed:

- Module Name
- Module Description
- Constraints, Limitations, or Unusual Features in the Design
- Special or Unique Algorithm Description
- Called by
- Calls
- Triggering Event (tasks only)
- Implicit Inputs
- Explicit Inputs
- Implicit Outputs
- Explicit Outputs
- Hardware Dependencies
- Sizing and Timing
- Informal Test Procedures

If computer aided design tools were used during phase two, such as the Computer-Aided Prototype System (CAPS), much of the information needed for the SDD is contained within the various reports that the tools produce.

3. Phase Three

At the completion of phase two the design of the current system has been extracted. Before starting the re-implementation of the system for the new target language and hardware, any changes to the design is done in this phase. This could be a re-organization to take advantage of any special capabilities of the compiler or hardware. In addition, this would be the time to modify the requirements of the system and fold those changes into the design. Upon completion of this phase the design should reflect the system as wanted by the customer.

4. Phase Four

The output of phase three is used in this phase. This is the coding of the extracted and possibly modified design. The detail design is re-implemented using the desired methodology (i.e. OOD, structured design, etc.) in the desired language for the desired target platform. This phase is executed in the same manner as any new development.

IV. THE CASE STUDY

A. THE TD1271B/U MULTIPLEXER DATA BUFFERING PROCESSOR

The Data Buffer Processor (DBP) provides the elastic buffering required to pass continuous data between the Systems Control Processor (SCP) and I/O ports while transmitting or receiving data in bursts over the satellite channel. The heart of the DBP consists of 24K bytes of EPROM containing the software program. The program is a loop structure which sequentially scans internal control points and the baseband users to determine the actions is required. If, for example, a user terminal has entered a transmit request at the baseband I/O port, a check is made of the port requirements, the port is configured to receive data and the transmit acknowledge is sent to the baseband device[43]. Figure 4-1 provides a block diagram of the relevant input and output signals to the DBP.[4]

B. DBP INPUT/OUTPUT SIGNALS

The DBP[49] data flow is described in Figure 4-1. Figure 4-1 is a description of data and control signals that are input to or output from the DBP[49].

C. THE RE-ENGINEERING STRATEGY

One of the primary goals of this re-engineering effort was an attempt to use the existing source code to extract the design of the system and to produce well designed, portable code. Ada was used as the target language during the extraction process. Since this software was originally written before the advent of structured design, we didn't attempt to use an Object-Oriented Design approach, but used a structured design approach.

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[4] This listing is not complete for the TD1271. Certain hardware control lines are system dependent and would not be applicable to this re-engineering effort.

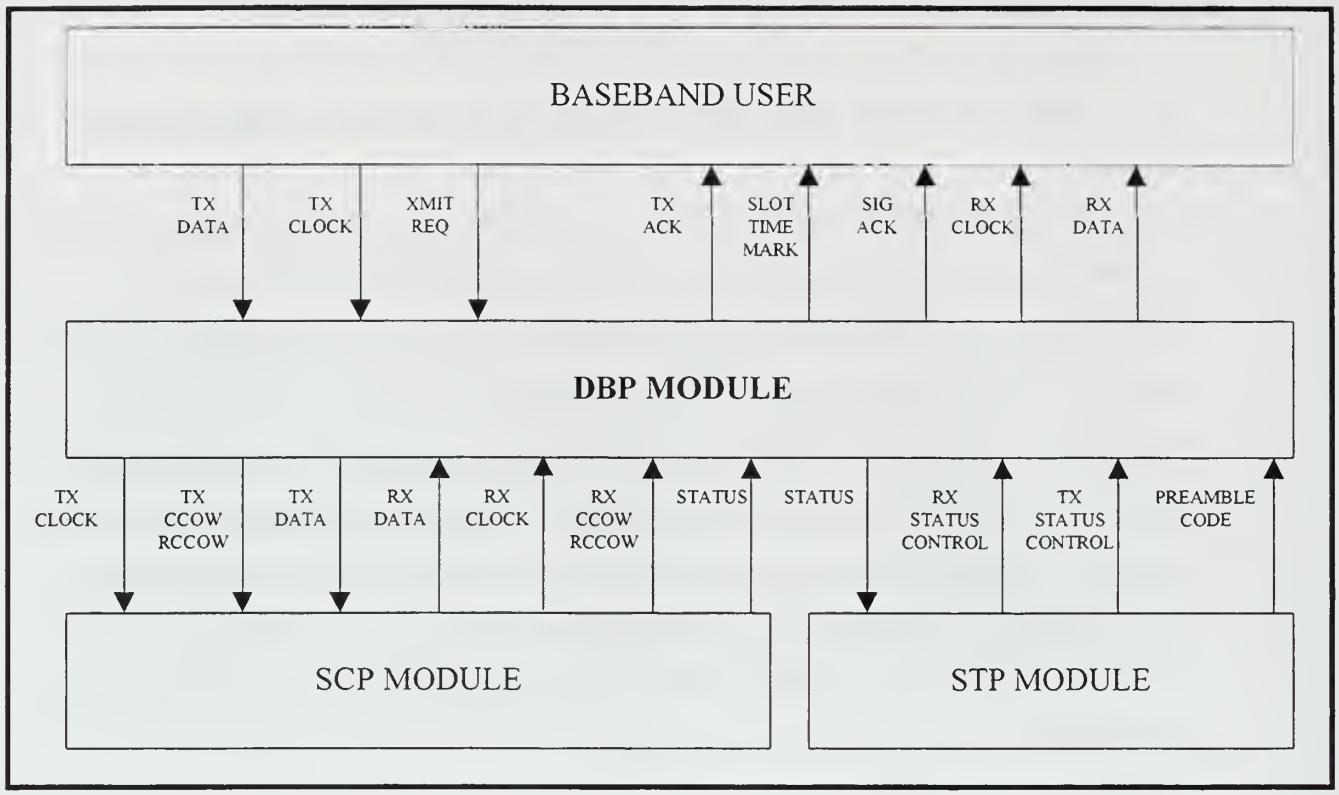

Figure 4-1
Inputs and Outputs To DBP Module

As outlined in Chapter 3, the first phase of the re-engineering effort is to develop Structural Diagram s, Module Descriptions, Data Flow Diagrams, Control Flow Diagrams, and State Transition Diagrams. The code was used to extract the structure, control flow, and state transition diagrams. The documentation was used to develop the module descriptions, provide a high level data-flow diagram and to verify the control flow and state transition diagrams whenever possible.

1. Code review

As noted by T. Bigerstaff [10], a key objective of design recovery is to develop structures that will enable a software engineer to understand the program. Our first step in this process was to identify and partition the code into procedures. This proved to be a task of greater difficulty that we had anticipated. Not only were we dealing with a

somewhat cryptic language, we were also faced with a coding style that extensively utilized 'jump' and 'branch' commands to navigate from one set of instructions to another. This programming style was intended to reduce the total size of the code by reusing existing code rather than re-writing it. Programmers coding during this period of time were highly praised if they could reduce the length of the overall program by even a few bytes, regardless of the long term maintenance problems created.

2. Extracting the Structure

The first step was to extract the modules from the code. Modules were defined as a section of code referenced in a Jump to Subroutine (JSR) or Branch to Subroutine (BSR). Even though it was recognized early on that this effort would focus only on part of the TD-1271 system it was important to extract the structure of the entire system to identify the areas in which the rest of the re-engineering effort would focus.

The code for the three major sub-systems were examined and mapped using a Microsoft Excel spreadsheet to record the results (see Appendix B - Subroutine Call Tree). It should be noted that this Subroutine Call Tree is not complete. The TD-1271 is not a procedural based design, that is it makes extensive use of GOTO statements for control between subroutines. The effort to extract the subroutine calls using the JSR/BSR opcodes was sufficient to identify which sub-system to apply the more rigorous code examination to. To produce the Subroutine Call Tree each file comprising the TD-1271 was opened in a word processor and a search was conducted on the words JSR and BSR. At each occurrence the subroutine containing the call and the subroutine that was being called were entered into the Subroutine Call Tree. Duplicate entries, the same subroutine call from the same subroutine, were not noted. The Subroutine Call Tree contains 1183 subroutine calls. After examining the results of this effort the Data Buffer Processor was selected for further investigation.

3. Extracting the Control Flow

In order to extract the control flow from the code it would be necessary to have some sort of cross reference available to consult. There weren't any tools available to do this so one was developed. A parser was written in Ada using an Alsys host compiler for

the IBM-PC. This parser uses two passes to build a cross reference for the labels in the source code and a source code listing with line numbers. The first pass identifies each label and the line of code where it is defined. The second pass identifies the line number of code where each reference occurs. References to labels that are not found are reported as errors. The only errors encountered were relative indexes based upon a label (e.g. LABEL1+2). The source code listing is in Appendix D and the Cross Reference Listing is in Appendix E. There will be references to line numbers in the source code from Appendix D later on.

A detailed examination of the DBP code identified the inter-subroutine control flow and a disturbing software design methodology, or to be more accurate - lack of one. As you can see by the control flow diagram, Figure 4-2, the designers used some programming practices that made it very difficult to extract the control flow. The first difficulty encountered was the use of multiple return from subroutine (RTS). Rather than having one entrance and exit from the subroutine there were multiple exits. This was further complicated by the use of GOTO statements where a JSR was used to enter a subroutine and both a RTS and a GOTO statement was used to return (IO1PT to IO1LF in Figure 4-2). There were subroutine calls where the called subroutine executed a GOTO statement to pass control, not back to the caller, but to another routine (IO1PT - IO1LS - IO2PT in Figure 4-2). There were manipulations of the return stack to short circuit the return from a subroutine call (Appendix D, line numbers 1044-1045 and 1099-1100 in IO1PT and repeated for the other three channels). There are examples in which a routine has multiple entrances and exits (Figure 4-3). The way this code was designed made it extremely difficult to convert to Ada, and impossible to meet the goal of having code that is well designed following this conversion. The result was becoming as poorly designed as the original. As stated earlier, this software was designed prior to the introduction of what is now considered modern programming standards. Design decisions were made based more upon memory usage and execution speed than having a system that was easy to maintain.

The subroutine IO1PT was examined for developing the inter-subroutine control flow. This was based upon the conditional statements within the code. This inter-

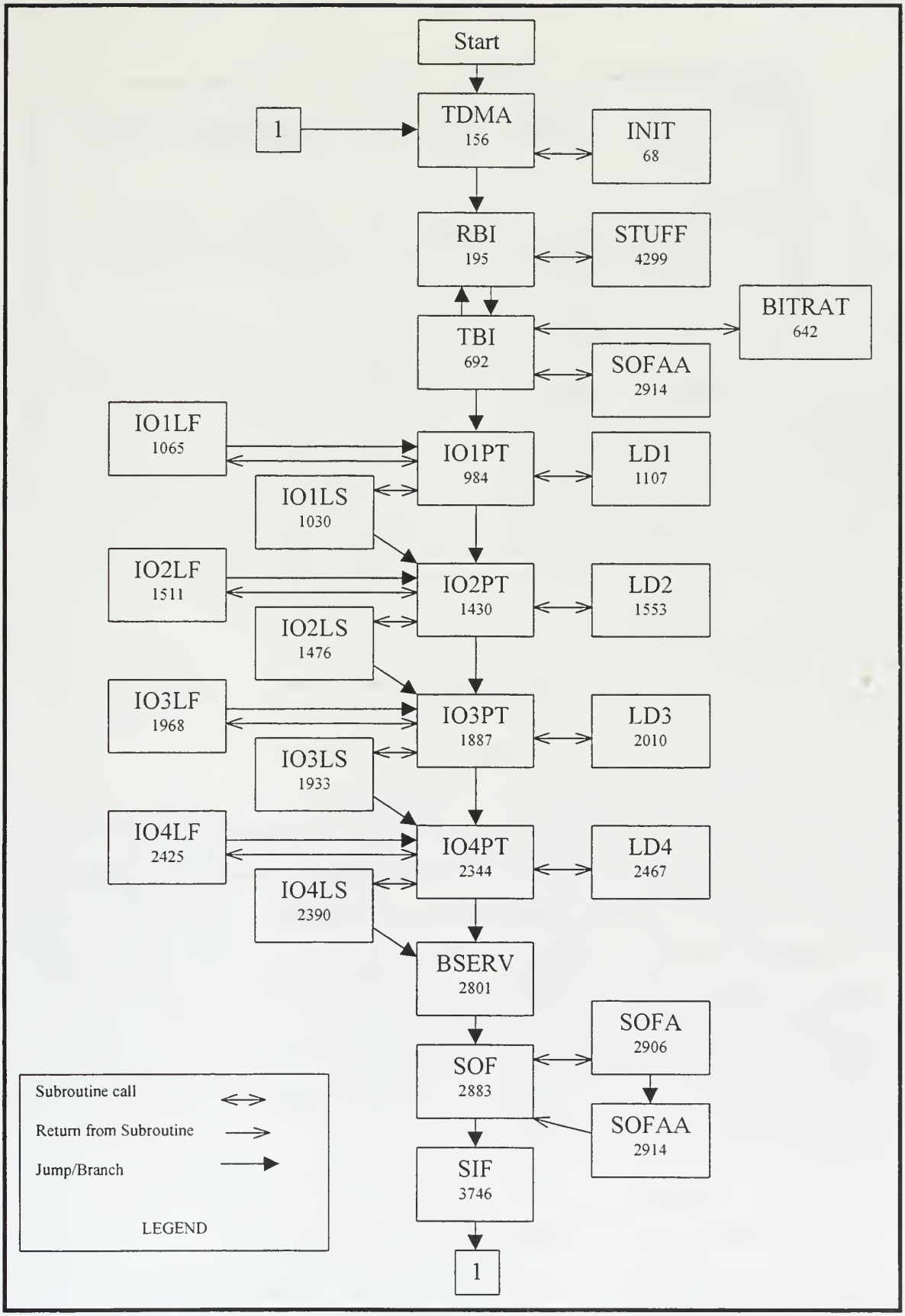

Figure 4-2

DBP Control Flow Diagram

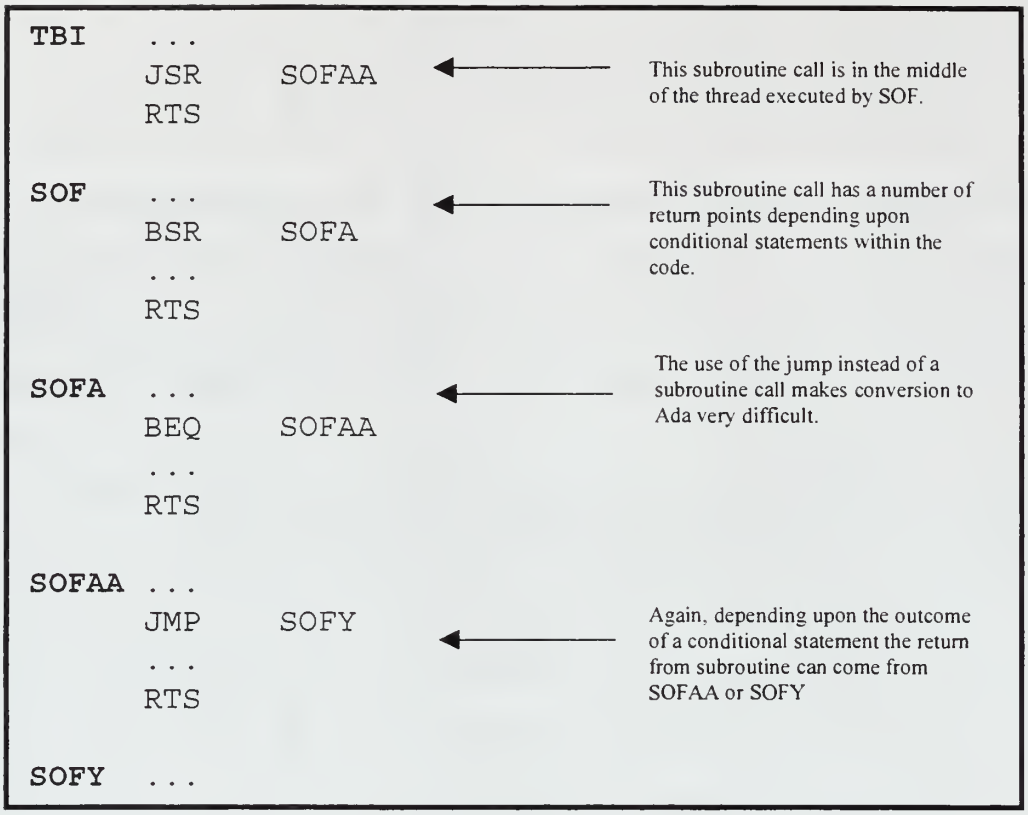
TBI ...
JSR SOFAA
RTS
This subroutine call is in the middle of the thread executed by SOF.
SOF ...
BSR SOFA
...
RTS
This subroutine call has a number of return points depending upon conditional statements within the code.
SOFA ...
BEQ SOFAA
...
RTS
The use of the jump instead of a subroutine call makes conversion to Ada very difficult.
SOFAA ...
JMP SOFY
...
RTS
Again, depending upon the outcome of a conditional statement the return from subroutine can come from SOFAA or SOFY
SOFY ...

Figure 4-3

Multiple Entrances and Exits

subroutine control flow was found to be as difficult to convert as the intra-subroutine control flow. The control flow for subroutine IO1A can be visualized with Figure 4-4. As Figure 4-4 depicts, this would be an example of "spaghetti code". In order to overcome this spaghetti code problem it became necessary to reduce the code to 'mini' routines, adding 'jumps' to the end of each code fragment, so each fragment would be a stand alone routine. Each fragment could then be moved at will to try to untangle the subroutine's control flow. It too was far more difficult than it was worth. The result was a subroutine that was poorly designed.

4. Data Flow

The data was analyzed to attempt to produce a data flow diagram. The primary data flow used ringed buffers. The declared buffer started at its own starting address and ended at the starting address of the next declared buffer (e.g. an index pointer was set to

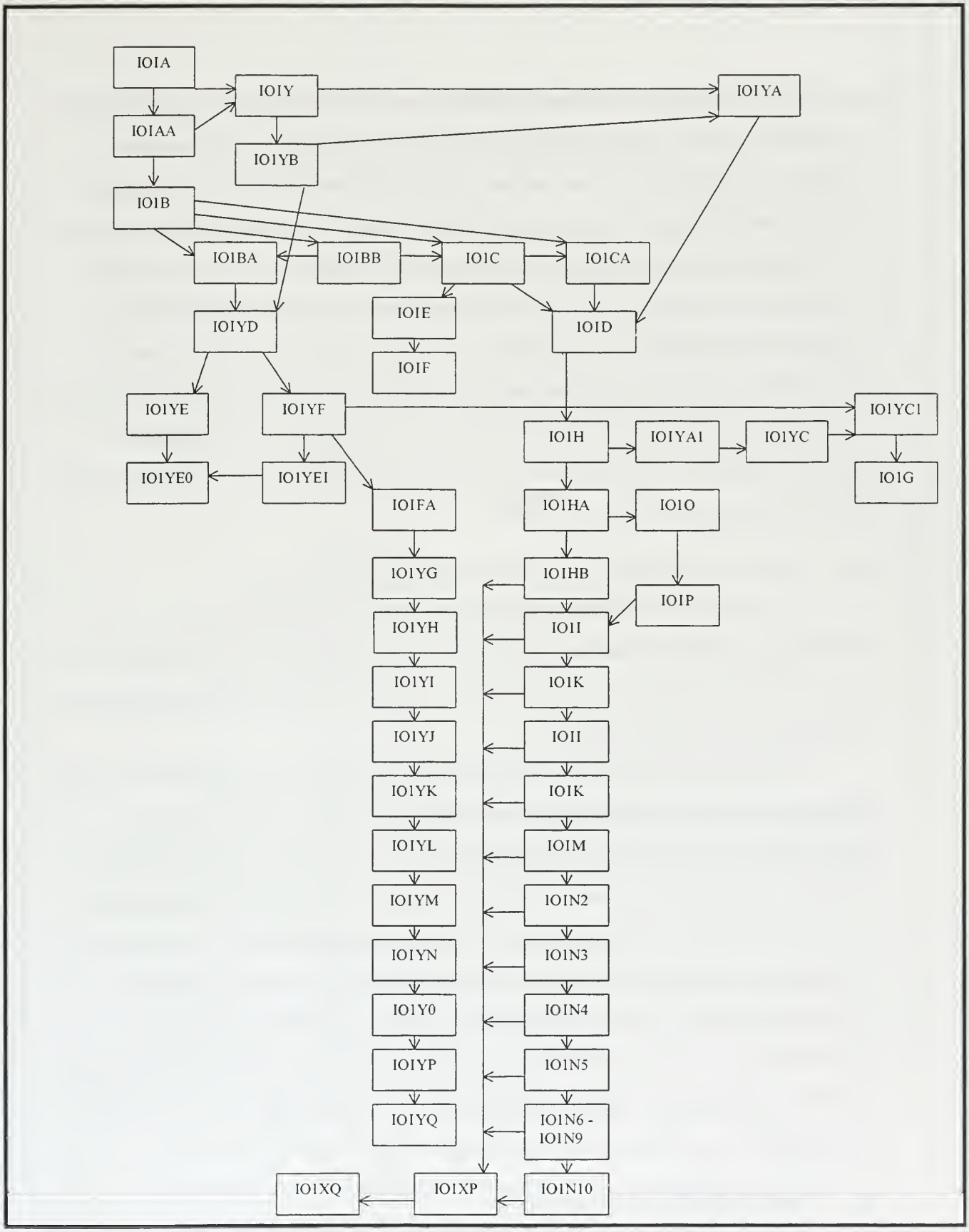

Figure 4-4
IO1A Control Flow

the starting address of a buffer and was incremented until it equaled the starting address of the next buffer). This hard coding is the easiest to overcome, but it is a glaring example of the way the software written. These ringed buffers can be easily defined using a ring buffer generic package in Ada where the data is inserted and extracted using procedure and function calls. Error handling can be included to cover the cases of underflow and overflow. The size of each buffer is then easily established during elaboration based upon the size specified. It was determined that the best source of information to establish a high level data flow diagram was the documentation. This data flow is shown in Figure 4-1. The data flow between the modules of the DBP are primarily indirect by using data stores. It was decided that the effort to describe this data flow was of little use and was not done.

D. USE OF THE TD-1271 AS AN ENGINEERING GUIDE

It was during the effort to establish the control and data flow diagrams that the determination was made that the TD-1271 should be redesigned from the top down. The source code as designed didn't support the re-engineering effort except as an engineering guide during the redesign processes.

The interrupt handlers can be used to establish the tasks responsible for the input and output of data to the DBP subsystem. While the modules are not suitable for re-engineering, the organization of the main modules can be useful in partitioning the new system. You can see by Figure 4-2 that there are four channels that are serviced in a round robin method. The new system can also use this organization. The most valuable asset the current TD-1271 has is by providing a system that works. A comparison between the behavior of the system to various inputs and what is specified in the documentation can give a good indication on the state of the documentation. It provides a strong baseline between stimulus and response that can assist in the formation of the new design.

E. DOCUMENTATION REVIEW

As was noted in the previous section, attempts to extract the requirements directly from the code became a prohibitively tedious and difficult task. This left only the

original documentation with which to attempt to baseline the requirements. The primary documentation available for the Data Buffer Processor program includes the Program Performance Specification (PPS) [49], the Program Design Specification (PDS) [50]. Also available are the system level PPS [46] and PDS [47] for the TD1271B/U. The factors and problems noted about documentation in Chapter I are evident in the TD1271B/U's documentation, and bring it's overall accuracy into question. The documents do however provide the basic requirements as they were known as late as 1987. It is these requirements that we shall briefly examine within this section relative to the re-engineering plan detailed in Chapter III.

1. Phase One: Architecture Definition.

a. Structure Chart

The DBP PDS [50, page 3-1] provides a basic structure chart. This is reproduced here as Figure 4-5. This structure chart does not include the modules for initialization and setup.

b. Module Description

Module descriptions for the six 'run time' modules are provided in both the PPS and in the PDS for the DBP. Setup and initialization are not specifically listed. Briefly these six modules are:

1. Receive Burst Initialization Module (RBI). This function processes the receive burst notification from the System Timing Processor. It initializes the DBP's hardware, the I/O ports flags and pointers, and the Service Receive Burst FIFO function.
2. Transmit Burst Initialization Module (TBI). This function processes the receive burst notification from the System Timing Processor. It initializes the DBP's hardware, the I/O ports flags and pointers, and the Service Transmit Burst FIFO function.

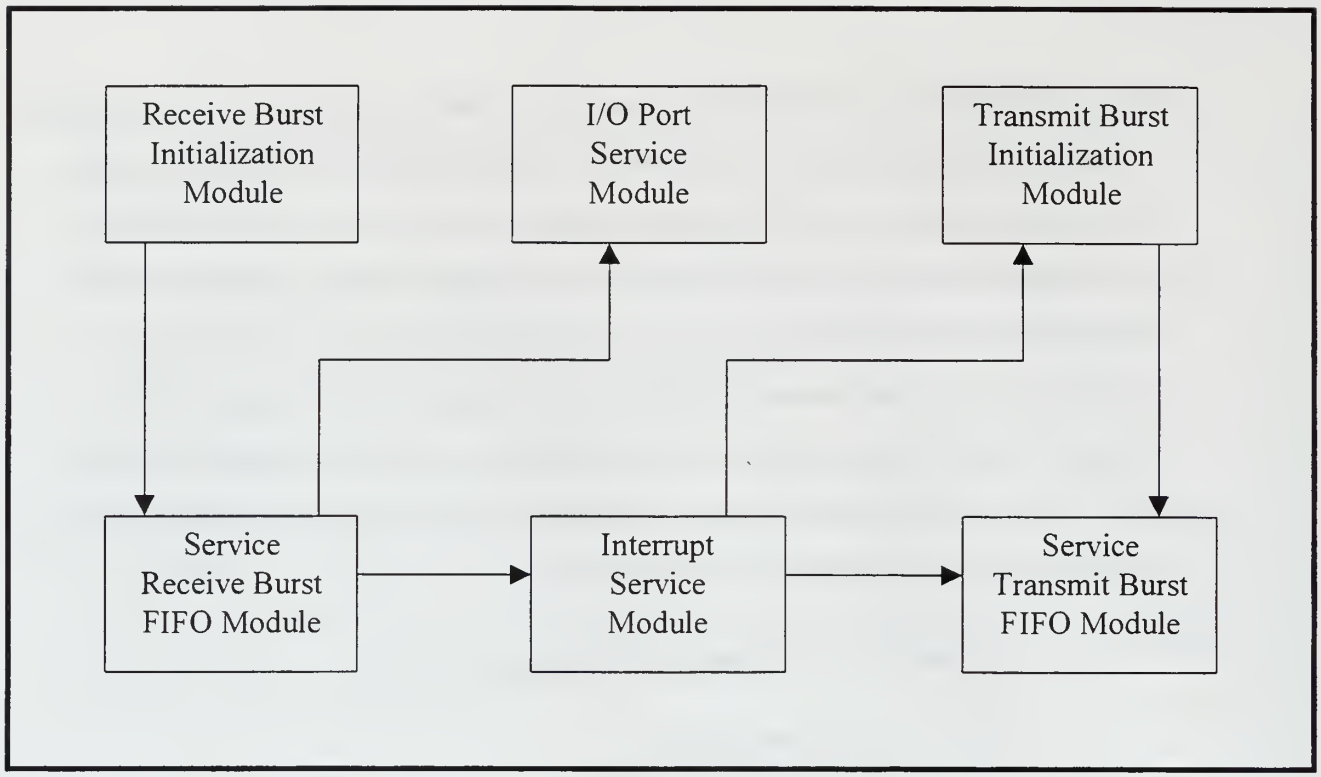
Receive Burst Initialization Module
I/O Port Service Module
Transmit Burst Initialization Module
Service Receive Burst FIFO Module
Interrupt Service Module
Service Transmit Burst FIFO Module

Figure 4-5
DBP High Level Structure Chart

3. I/O Port Service Module (IO1PT-IO4PT). These four modules services each of the four baseband ports. If the I/O Transmit Request input is true, the DBP will accept I/O port data and store it in the port's data buffer. If the I/O Transmit Request input is false and there is receive burst data for the port, then the I/O port service will output this data from the data buffer to the baseband equipment.

4. Service Receive Burst FIFO Module (SIF). This module inputs receive burst channel data and stores it in the data buffer.

5. Service Transmit Burst FIFO Module (SOF). This module outputs the I/O port's transmit data from the data buffer to the burst channel.

6. Interrupt Service Module (IRS). This module communicates with the System Control Processor. It receives I/O port bit rate and connection status, and it receives/transfers orderwire messages on an interrupt basis [49].

c. Data flow

The Data Flow is somewhat more difficult to extract from the documentation. By definition in the DOD-STD-1679A [51], the full definition of data variables would be documented either in the Program Design Document or in the Database Design Document. To date we have not found any reference to either of these documents. It is our belief that they were tailored out of the documentation package for the original development. This leaves some of the inputs and outputs listed in the DBP PPS and PDS open to question as to their origin and content. Clearly this is an area where it would be necessary to track the variables through out the code to ascertain their design and functions. In addition to the program variables, there are an assortment of Key Lines, Clocks, and Interrupts that need to be processed and input. Figure 4-1 provides a block diagram of the inputs and output from the DBP module.

d. Control flow

From the DBP PDS we were able to extract the basic control flow diagram. This diagram (Figure 4.6) would provide the sequencing of tasks in the new software module. It would also provide the basis for the modules for the Data Flow diagram. In addition to this 'basic' control flow, there is also an Interrupt handling module capable of stopping current processing and shifting control to another module.

2. Phase Two: Requirements Definition.

The second part of the re-engineering effort is to utilize the data gathered from the first phase to develop requirements. The high level requirements can be easily extracted from the module descriptions.

R1: Will receive burst timing from System Timing Processor.

R2: Will initialize hardware and software flags and statuses

R3: Will input data from the Baseband ports and store.

R4: Will receive data from the channel and store.

R5: Will forward input data from storage to the channel.

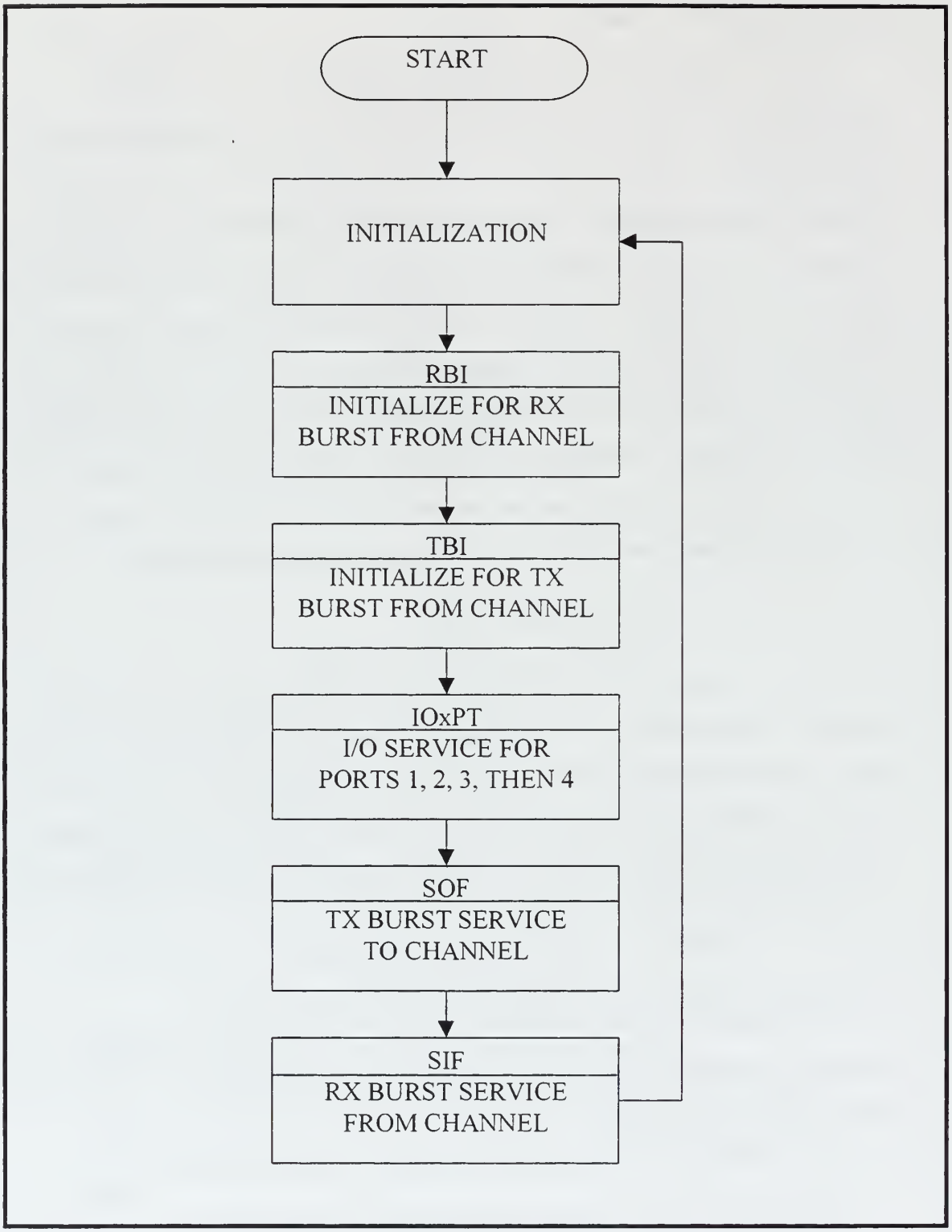

Figure 4-6
Control Flow Diagram

R6: Will output receive data from storage to the Baseband port.

R7: Will receive and transfer orderwires to and from the System Control Processor.

R8: Will receive port status and connection information from the System Control Processor.

From this point, development of more detailed requirements would progress along normal development lines. The advantage that would be gained in this area would be the ability to check the foundation of a requirement in the code. In this way the 'forward' engineering effort would have a existing system to validate the responses against.

F. RECOMMENDATIONS

Effort can be expended to convert the TD-1271 to a high order language and have it run on any number of modern day processors. To do so without reengineering the system from the top down will in effect doom this system to the same fate it has fallen to today: unstructured and not maintainable.

One of the obvious recommendations would be to use a modern programming language. Because of the use of ring buffers between the subsystems, a method that is valid in a new design, Ada would be the best choice. This would allow the use of generic packages to handle the buffers. Ada's tasking and the ability to tie the task's entry point to a hardware interrupt would be another valuable feature that makes Ada the first choice.

The original thesis called for timing studies to be conducted on the re-engineered code. Since the code never reached the state where these studies could be performed there aren't any hard numbers to address. However, the current system runs on three Motorola 6800 microprocessors. The increase in the processors throughput since the Motorola 6800 introduction would give a good indication that the entire system could fit on any number of modern day microprocessors. The hard real time requirement is handling the input from the modem. This data is transmitted at a maximum rate of 16K bits/second. Most real-time embedded applications use Wind River's VxWorks operating system. This operating system allows the application to read a serial port with a variable input size. The programmer specifies the file descriptor for the serial port, the address in

which the data is to be read, and the number of bytes to read. In addition, VxWorks provides an optimized task switch for interrupt handlers that has the overhead of a function call. Once the data has been read in the data is output as processed. By proper scaling of the input data from the modem, the processing percentage spent on handling the interrupt can be less than 10%. With these considerations our recommendation would be either the Motorola 68040 or the Motorola Power-PC.

V. CONCLUSIONS

This thesis was originally planned to be a fairly straight forward application and review of the re-engineering process. We very rapidly ran into problems of scope and time. There is a tremendous amount of data written on the subject of re-engineering. The re-engineering data not only covered software, but also included business, hardware, and other re-engineering topics. The first problem we faced was separating out the relevant topics. After 'narrowing' the scope to software re-engineering, we were still faced with a daunting amount of information to review. We found a great deal of information presented on the general theory of re-engineering, but very little concrete information on the application of these theories. We were able to locate a methodology to try [30].

The first phase of this methodology is the extraction of data from the existing code. As noted by Byrne (30), tool support for this portion is a major necessity. With appropriate tools it is possible to statically analyze and document an extensive program in a relatively short period of time. He estimates a 150 to 1 time ratio difference between manual analysis to an automated tool approach. Based on our experience, we would concur with this evaluation. We were unable to locate any tool support to automate the extraction of basic calling trees or other data from the legacy system we were looking at. Although some were found for high order languages, there were very few listings for any Assembly language, and none of these were for the Motorola 6800. This we believe will be prevalent in most legacy systems. Most of the legacy systems will be in some form of Assembly language, but there are not enough in any one language to make it commercially feasible to develop a tool to automate this portion of the re-engineering process.

When faced with poorly designed software it is important to start the re-engineering work at the lowest level in which the design is masked. For example, the preliminary design may be adequate and it was in the execution of the design that the poor design decisions were made. However, it is more likely that the designers, knowing the constraints of the environment in which they have to operate, like available memory,

will design to make optimum use of the resources available. There are examples in which the software was written with self-modifying code in order to recover memory space used for initialization as scratch pads for data. However, when re-engineering the system these type of design decisions need to be abandoned and the software needs to be designed to the standards of the times.

With the TD-1271, a tremendous amount of time was used in just trying to understand and decipher the source code. The software, with little or no comments (see Appendix D) and poorly designed control structure, cannot be recommended for re-engineering. Time and effort could be expended to re-engineer the source code: It`s not an impossible task, but it is not cost effective. Nor would the result have enhanced the supportability of the software.

The only reasonable approach for the TD1271B/U would be to start at the requirements documentation, establish a testing criteria for each requirement, and perform those tests on the existing system. These tests would demonstrate if there have been modifications to each requirement that would warrant further investigation to determine the current state of that requirement. Once the modifications to the requirements have been made and a suitable target system identified, the task of re-writing the software would be considered a small to medium effort when weighed against current Navy communications systems currently under development.

APPENDIX A

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45	FSCS-211-24-1 Revision A, UHF Demand Assigned Multiple Access (DAMA) Systems Interface Design Specification For The UHF Satcom Satellite Waveform, dtd 15 January 1985
46	FSCS-212-16 Revision D, UHF Demand Assigned Multiple Access (DAMA) System TD-1271B/U Multiplexer Program Performance Specification, dtd 01 September 1987

47	FSCS-212-17 Revision A, UHF Demand Assigned Multiple Access (DAMA) Systesm TD-1271B/U Multiplexer Program Design Specification, dtd 01 September 1987
48	FSCS-212-26-2 (CH-1), Interface Control Document For The TD-1271B/U Multiplexer (Distributed Control Mode), dtd 30 September 1990
49	FSCS-212-7 Revision A, UHF Demand Assigned Multiple Access (DAMA) Systesm TD-1271B/U Multiplexer Program Performance Specification Data Buffer Processor, dtd 15 May 83
50	FSCS-212-8 Revision A, UHF Demand Assigned Multiple Access (DAMA) Systesm TD-1271B/U Multiplexer Program Design Specification Data Buffer Processor, dtd 01 September 1987
51	DOD-STD-1679A(Navy) Military Standard Software Development, dtd 22 October 1983

APPENDIX B

A. TD-1271B/U SUBROUTINE CALL TREE

Module Name	Located in	Is Called by	Located in
0.X		FPANEL	FP
		SRX	STPV06
		STX0	STPV06
ACK_CC_RCCOW	PRECLA	EXAM_CCOW_OVRHED	PRECLA
ADJUST_FCOUNT_GS	GS	DBP_MSG_INTRPRT	DCEXEC
		DBP_MSG_INTRPRT	PREALT
		EXAM_CCOW_OVRHED	PRECLA
ALARM_ON_GS	GS	FPANEL	FP
		BEEP_ALARM_GS	GS
ALPHA_ONOFF_A_GS	GS	FPANEL	FP
		GLIST_DISPLY_FP	FP
		RECALL_FP	FP
		DC_HOME_FREQ_FP	FP
		AC_HOME_FREQ_FP	FP
		QUEUE_TIME_FP	FP
		CMD_RESPONSE_FP	FP
		FREQ_TO_DSPLY_FP	FP
		KG_TIME_TO_DSPLY	FP
		STATUS_RPT_B_FP	FP
		ZEROIZE_FP	FP
		CONFER_CALL_FP	FP
		INFO_REQUEST_FP	FP
		PAGING_REQ_FP	FP
		KG_MEM_CHANGE_FP	FP
		CONFIG_CODE_FP	FP
		DISP_INFO_REQ_GS	GS
		LAMP_TEST_GS	GS
		LNK_TST_RES_GS	GS
		ERR_GS	GS
		SHOW_PORT_GS	GS
ALPHA_ONOFF_B_GS	GS	FPANEL	FP
		INFO_REPORT_FP	FP
		RECALL_FP	FP
		ZEROIZE_FP	FP
		PORT_RELEASE_FP	FP
		DC_HOME_FREQ_FP	FP
		AC_HOME_FREQ_FP	FP
		SELECT_PORT_FP	FP
		PREC_ENTER_FP	FP
		KG_MEM_FILL_FP	FP
		INFO_REQ_CHK_FP	FP
		EXIT_FP	FP
		LINK_TEST_REQ_FP	FP
		CALL_COMPLETE_FP	FP
		CHAN_CONTROL_FP	FP
		OUT_OF_SERV_FP	FP
		TO_PARITY_CALL_FP	FP
		FORMAT_FREQ_FP	FP
		CONFER_CALL_FP	FP
		KG_TIME_FP	FP

Module Name	Located in	Is Called by	Located in
ALPHA_ONOFF_B_GS	GS	CALL_CANCEL_FP	FP
		INFO_REQUEST_FP	FP
		PAGING_REQ_FP	FP
		KG_MEM_CHANGE_FP	FP
		STG_CONTROL_FP	FP
		CONFIG_CODE_FP	FP
ALPHA_ONOFF_B_GS	GS	LNK_TST_RES_GS	GS
		CALL_CC_GS	GS
		DISP_FCNT_GS	GS
AUDIO_ALARM_01	FP	FPANEL	FP
AUDIO_ALARM_02	FP	INFO_REQ_CHK_FP	FP
AUDIO_ALARM_OFF	FP	FPANEL	FP
		KG_MEM_FILL_FP	FP
BCD_TO_BIN_GS	GS	INFO_REQUEST_FP	FP
		YZ_TO_BIN_FP	FP
		AC_HOME_FREQ_FP	FP
		VWXYZ_TO_BIN_FP	FP
BCD_TO_YZ_FP	FP	FPANEL	FP
		FREQ_TO_DSPLY_FP	FP
		DC_HOME_FREQ_FP	FP
BEEP_ALARM_GS	GS	FPANEL	FP
		INFO_REPORT_FP	FP
		PORT_RELEASE_FP	FP
		DC_HOME_FREQ_FP	FP
		AC_HOME_FREQ_FP	FP
		SELECT_PORT_FP	FP
		PREC_ENTER_FP	FP
		KG_MEM_FILL_FP	FP
		CMD_RESPONSE_FP	FP
		PRE_DCKA_CHK_FP	FP
		CHAN_CONTROL_FP	FP
		LINK_TEST_REQ_FP	FP
		ZEROIZE_FP	FP
		STATUS_RPT_B_FP	FP
		CALL_COMPLETE_FP	FP
		OUT_OF_SERV_FP	FP
		TO_PARITY_CALL_FP	FP
		FORMAT_PARITY_FP	FP
		CONFER_CALL_FP	FP
		KG_TIME_FP	FP
		CALL_CANCEL_FP	FP
		INFO_REQUEST_FP	FP
		PAGING_REQ_FP	FP
		EXTEND_XMIT_FP	FP
		KG_MEM_CHANGE_FP	FP
		STG_CONTROL_FP	FP
		CONFIG_CODE_FP	FP
		PORT_DETECT_GS	GS
		LNK_TST_RES_GS	GS
		ERR_GS	GS
BIN_TO_BCD_CL_GS	GS	FPANEL	FP
		DC_HOME_FREQ_FP	FP
		AC_HOME_FREQ_FP	FP
		QUEUE_TIME_FP	FP
		DISCOTIME_DISPLAY	FP
		FREQ_TO_DSPLY_FP	FP
		KG_TIME_TO_DSPLY	FP

Module Name	Located in	Is Called by	Located in
BIN_TO_BCD_GS	GS	FPANEL	FP
		RECALL_FP	FP
		INFO_REQ_CHK_FP	FP
		FREQ_CODE_CHK_FP	FP
		GLIST_DISPLY_FP	FP
		LNK_TST_RES_GS	GS
BIT_RATE_FIND	DCMOW	CALL_REQUEST	DCMOW
BITE_CLEAR	DCMOW	RRU_INTRPRT	DCMOW
		CALL_REQUEST	DCMOW
		DATA_XFER	DCMOW
		GLIST_DISP	DCMOW
		CALL_COMPLETE	DCMOW
		INFO_REPORT	DCMOW
		RRU_INTRPRT	PREINT
		RRU_STATUS_RPTB	PREINT
		DATA_XFER	PREINT
		GLIST_DISPLAY_05	PREINT
		CALL_COMPLETE	PREINT
		RRU_PRTY_OUT_05	PREINT
		INFO_REPORT_05	PREINT
		CALL_REQ_05	PREINT
		CONFIG_ENTRY_05	PREINT
		RRU_CALLCAN_05	PREINT
		GLIST_ENTDEL_10	PREINT
		PAGING_RCOW	PREINT
		CONF_REQUEST	PREINT
BITRAT	DBPV4	RBIJ	DBPV4
		RBIT	DBPV4
BLINK_SCULITE_GS	GS	EXEC_DCEXEC	DCEXEC
		EXEC_PREALT	PREALT
		CHECKSUM_CHK_GS	GS
BRX	STPV06	CONFIG	STPV06
BSB	STPV06	EXEC	STPV06
		PSA	STPV06
BTX	STPV06	CONFIG	STPV06
CALC_PARITY_GS	GS	XFER_CCOW_TO_DBP	DCEXEC
		IN_CCOW_FROM_DBP	DCEXEC
		ENCRYPT_CCOW	DCEXEC
		DECRYPT_CCOW	DCEXEC
		XFER_RCOW_DBP_GS	GS
		DECRYPT_RCOW_GS	GS
		READ_DBP_RCOW_GS	GS
		ENCRYPT_RCOW_GS	GS
		IN_CCOW_FROM_DBP	PREALT
		ENCRYPT_CCOW	PREALT
		DECRYPT_CCOW	PREALT
		XFER_OW	PREALT
CALL_CC_GS	GS	PORT_DETECT_GS	GS
CALL_COMPLETE_FP	FP	JUMP_COMPLETE_GS	GS
CALL_QUE_UPDATE	PREINT	CALL_IN_QUE_ACK	PREINT
		CALL_IN_QUE	PREINT
CALL_REQ_DCMOW	FP	CALL_REQUEST	DCMOW
		TO_PARITY_CALL_FP	FP
CC_EXEC_DCCNTR	DCCNTR	EXEC_DCEXEC	DCEXEC
CC_EXEC_PRECLA	PRECLA	EXEC_PREALT	PREALT

Module Name	Located in	Is Called by	Located in
CCOW_INTP_DCMOW	DCMOW	EXEC_DCEXEC	DCEXEC
		USEREXEC	DCEXEC
CCOW_INTP_PREINT	PREINT	USEREXEC	PREALT
CHECK_A_RANGE	DCMOW/PREINT	PORT_DISCONNECT	DCMOW
		PORT_DISCONNECT	PREINT
CHECK_B_RANGE	PREINT	PORT_DISCONNECT	DCMOW
		PORT_DISCONNECT	PREINT
CHECK_C_RANGE	DCMOW/PREINT	PORT_DISCONNECT	DCMOW
		PORT_DISCONNECT	PREINT
CHECKSUM_CHK_GS	GS	INIT_DCEXEC	DCEXEC
		INIT	PREALT
CHK_FRAME_COUNT	PRECLA	FRAME_CHK_PRECLA	PRECLA
CHK_GLIST	PREINT	SLOT_DISCONNECT	PREINT
		CALL_WAITING	PREINT
		HOME_CHAN_CHANG	PREINT
		SLOT_CONNECT	PREINT
		FORMAT_CHANGE	PREINT
CLEAR	DBPV4	PWRON	DBPV4
		SETUP	DBPV4
CLEAR_CONT_COUNT	PREINT	BUSY_ACK	PREINT
		CALL_IN_QUE_ACK	PREINT
		USER_OUT_ACK	PREINT
		CALL_ACK	PREINT
CLEAR_DISP_GS	GS	FPANEL	FP
		SHOW_PORT_GS	GS
CLEAR_GNUM	PREINT	RPT_GLIST1	PREINT
		RPT_GLIST2	PREINT
		RPT_GLIST3	PREINT
		RTP_GLIST4	PREINT
CLEAR_GUARD_LIST	DCMOW	FRAME_FMT_UPDATE	DCMOW
CLEAR_LITES_TIME	PREINT	CALL_CANCEL	PREINT
CLEAR_QUE_TIME	PREINT	SLOT_CON_UPDATE	PREINT
		RRU_CALLCAN_15	PREINT
CLEAR_SLOTS_GS	GS	PORT_DISCONNECT	DCMOW
		CHAN_CONTROL_FP	FP
		STATUS_PRECLA	PRECLA
		ZEROIZE	PREINT
		PORT_DISCONNECT	PREINT
CLR_RRU_05	PREALT	RRU_MSG_UPDATE	DCEXEC
CLR_RRU_PREC_DSP	DCEXEC/PREALT	RRU_MSG_UPDATE	DCEXEC
		RRU_MSG_UPDATE	PREALT
CLRTIM	PREINT	BUSY_ACK	PREINT
		USER_OUT_ACK	PREINT
		SLOT_CON_UPDATE	PREINT
		CALL_CANCEL	PREINT
		PARTY_OUT_OF_SYNC	PREINT

Module Name	Located in	Is Called by	Located in
CMD_RESPONSE_FP	FP	ZEROIZE_FP	FP
		INFO_REPORT_FP	FP
		TO_PARITY_CALL_FP	FP
		FORMAT_FREQ_FP	FP
		CONFER_CALL_FP	FP
		DC_HOME_FREQ_FP	FP
		AC_HOME_FREQ_FP	FP
		KG_TIME_FP	FP
		INFO_REQUEST_FP	FP
		GLIST_ENTER_FP	FP
		PAGING_REQ_FP	FP
		KG_MEM_CHANGE_FP	FP
		GLIST_DELETE_FP	FP
		STG_CONTROL_FP	FP
		CONFIG_CODE_FP	FP
		CHAN_CONTROL_FP	FP
COMMAND_FRAME	PREINT	CCOW_INTP_DCMOW	DCMOW
		CCOW_INTP_05	PREINT
COMP_FRAME_GS	GS	FRAME_CHK_DCCNTR	DCCNTR
		FRAME_CHK_PRECLA	PRECLA
		MASTER_FRAME	PREINT
CONFIG_CODE_GS	GS	INFO_REQ_CHK_FP	FP
CONS	STPV06	CONFIG	STPV06
CONT_CHK_PREINT	PREINT	RCOW_PREP_XMIT	PREALT
		CLEAR_CONT_COUNT	PREINT
		READ_CALL_ACK	PREINT
CORRECT_ONE_BCD	GS	BCD_TO_BIN_GS	GS
CORRECT_TWO_BCD	GS	BIN_TO_BCD_GS	GS
CYCLELITES_DCMOW	DCMOW	ZEROIZE	DCMOW
		TS_PREP	DCMOW
		INFO_REQUEST_GS	GS
DBP_MSG_INT_30	DCEXEC/PREALT	EXEC_PREALT	PREALT
DBP_MSG_INT_35	DCEXEC/PREALT	EXEC_DCEXEC	DCEXEC
DBP_MSG_INTRPRT	DCEXEC/PREALT	USEREXEC	DCEXEC
		USERPREAC	DCEXEC
		USERPREAC	PREALT
		USEREXEC	PREALT
DCKPORTOFF_GS	GS	INFO_REQUEST_GS	GS
		PORT_DETECT_GS	GS
DECODE_FP	FP	FPANEL	FP
		KG_MEM_FILL_FP	FP
DECRYPT_CCOW	DCEXEC/PREALT	DBP_MSG_INTRPRT	DCEXEC
		DBP_MSG_INTRPRT	PREALT
DECRYPT_RCOW_GS	GS	DBP_MSG_INTRPRT	DCEXEC
		DBP_MSG_INTRPRT	PREALT
DEL_FROM_GLIST	PREINT	DELET_GUARD_LIST	PREINT
		GLIST_ENTDEL_30	PREINT
DELAY_TOGGLE_GS	GS	STATUS_DCCNTR	DCCNTR
		CC_EXEC_PRECLA	PRECLA
		RCV_CCOW_BLOCK	PRECLA
		STATUS_PRECLA	PRECLA
DID	STPV06	RNGEXC	STPV06
		LTEXEC	STPV06

Module Name	Located in	Is Called by	Located in
DISCO_SLOT_CHK	DCMOW/PREINT	CHECK_A_RANGE	DCMOW
		CHECK_B_RANGE	DCMOW
		CHECK_C_RANGE	DCMOW
		CHECK_A_RANGE	PREINT
		CHECK_B_RANGE	PREINT
		CHECK_C_RANGE	PREINT
DISCOTIME_DISPLY	FP	FPANEL	FP
		RECALL_FP	FP
DISP_FCNT_GS	GS	ZEROIZE_FP	FP
		CHAN_CONTROL_FP	FP
		DC_HOME_FREQ_FP	FP
		AC_HOME_FREQ_FP	FP
		SELECT_PORT_FP	FP
		CALL_COMPLETE_FP	FP
		STATUS_RPT_B_FP	FP
		GLIST_DISPLY_FP	FP
		LINK_TEST_REQ_FP	FP
		INFO_REPORT_FP	FP
		TO_PARITY_CALL_FP	FP
		FORMAT_FREQ_FP	FP
		CONFER_CALL_FP	FP
		KG_TIME_FP	FP
		CALL_CANCEL_FP	FP
		INFO_REQUEST_FP	FP
		GLIST_ENTER_FP	FP
		PAGING_REQ_FP	FP
		KG_MEM_CHANGE_FP	FP
		GLIST_DELETE_FP	FP
		STG_CONTROL_FP	FP
		CONFIG_CODE_FP	FP
		OUT_OF_SERV_FP	FP
		LNK_TST_RES_GS	GS
DISP_INFO_REQ_GS	GS	FPANEL	FP
DISP_VWXYZ_GS	GS	FPANEL	FP
		RECALL_FP	FP
		LNK_TST_RES_GS	GS
DISPLAY_EEEEE_GS	GS	GLIST_DISPLY_FP	FP
		ERR_GS	GS
DISPLY_TO_BCD_GS	GS	FORMAT_FREQ_FP	FP
		AC_HOME_FREQ_FP	FP
		VWXYZ_TO_BIN_FP	FP
		YZ_TO_BIN_FP	FP
		WX_TO_BCD_FP	FP
		YZ_TO_BCD_FP	FP
		CONFIG_CODE_FP	FP
ENCRYPT_CCOW	DCEXEC/PREALT	EXEC_DCEXEC	DCEXEC
		EXEC_PREACT	PREALT
ENCRYPT_RCOW_GS	PREALT	RCOW_PREP_XMIT	DCEXEC
		RCOW_PREP_XMIT	PREALT
EQUIPLED_REDO	FP	FPANEL	FP

Module Name	Located in	Is Called by	Located in
ERR_GS	GS	ZEROIZE_FP	FP
		INFO_REPORT_FP	FP
		TO_PARITY_CALL_FP	FP
		FORMAT_FREQ_FP	FP
		CONFER_CALL_FP	FP
		KG_TIME_FP	FP
		INFO_REQUEST_FP	FP
		GLIST_ENTER_FP	FP
		PAGING_REQ_FP	FP
		EXTEND_XMIT_FP	FP
		GLIST_DELETE_FP	FP
		GLIST_DISPLAY_FP	FP
EVEN_PORT_STORE	PREINT	RRU_STATUS_RPTB	PREINT
EXAM_CCOW_OVRHED	PRECLA	RCV_CCOW_BLOCK	PRECLA
EXIT_FP	FP	TIME_CHK_DCCNTR	DCCNTR
FIND_GLIST	PREINT	ENTER_GUARD_LIST	PREINT
		DELET_GUARD_LIST	PREINT
FIND_GLIST_05	PREINT	GLIST_DISPLAY_05	PREINT
		GLIST_ENTDEL_10	PREINT
		GLIST_ENTDEL_30	PREINT
FIND_PREMPT_ADR	PREINT	PREMPTCOUNT_REDO	PREINT
		SLOT_CON_UPDATE	PREINT
		RRU_DISCO	PREINT
FIND_RRU_BUF_GS	GS	SETUP1	DCMOW
		CALL_REQUEST	DCMOW
		LITES_OFF_DCMOW	DCMOW
		DATA_XFER	DCMOW
		LNK_TST_LAMP_GS	GS
		LNK_TST_RES_GS	GS
		RRU_ACPT_ON_GS	GS
		INFO_REQUEST_GS	GS
		RRU_DISCO	PREINT
		READ_CALL_ACK	PREINT
		CALL_IN_QUE_ACK	PREINT
		USER_OUT_ACK	PREINT
		RRU_OUT_ADR	PREINT
		SLOT_CON_UPDATE	PREINT
		CALL_CANCEL	PREINT
		CALL_WAITING	PREINT
		CALL_IN_QUE	PREINT
		CCOW_DATA_XFER	PREINT
		PARTY_OUT_OF_SVC	PREINT
		LITES_OFF_PREINT	PREINT
		RRU_CALL_CAN_05	PREINT
		DATA_XFER	PREINT
FIND_RRU_QUE	PREINT	DEDICATED_SLOT	PREINT
		BUSY_ACK	PREINT
		CALL_WAITING	PREINT
		FIND_RCOW_QUE	PREINT
		CALL_QUE_UPDATE	PREINT
FIND_RRUQUE_ADR	PREINT	OUT_SVC_UPDATE	PREINT
		CLEAR_QUE_TIME	PREINT

Module Name	Located in	Is Called by	Located in
FIXA_GS	GS	FPANEL	FP
		CONFER_CALL_FP	FP
		QUEUE_TIME_FP	FP
		DISCOTIME_DISPLAY	FP
		KG_MEM_FILL_FP	FP
		FREQ_TO_DSPLY_FP	FP
		PAGING_REQ_FP	FP
		KG_MEM_CHANGE_FP	FP
		LINK_TEST_REQ_FP	FP
		FIXAB_GS	GS
FIXAB_GS	GS	FPANEL	FP
		SHOW_YZ_GS	GS
		SHOW_WX_GS	GS
		FIXA_GS	GS
FIXB_GS	GS	QUEUE_TIME_FP	FP
		DISCOTIME_DISPLAY	FP
		CMD_RESPONSE_FP	FP
		FREQ_TO_DSPLY_FP	FP
		DISPLY_TO_BCD_GS	GS
FMT_GLIST_RCW_05	PREINT	SET_GLIST_PTR	PREINT
FMT_GLIST_RCW_15	PREINT	SET_GLIST_PTR	PREINT
FMT_GLIST_RCW_40	PREINT	SET_GLIST_PTR	PREINT
FMT_GLIST_RCW_55	PREINT	CLEAR_GNUM	PREINT
FORMAT_UPDATE	PREINT	FORMAT_CHANGE	PREINT
FORMAT_GLIST_RCW	PREINT	RPT_GLISTI	PREINT
FP_RCOW	DCEXEC/PREALT	USEREXEC	DCEXEC
		USERPREAC	DCEXEC
		USERPREAC	PREALT
		USEREXEC	PREALT
FPANEL_FP	FP	USEREXEC	DCEXEC
		USERPREAC	DCEXEC
		USEREXEC	PREALT
		USERPREAC	PREALT
FRAME_CHK_DCCNTR	DCCNTR	USEREXEC	DCEXEC
		USERPREAC	DCEXEC
		DBP_MSG_INTRPRT	DCEXEC
FRAME_CHK_PRECLA	PRECLA	USEREXEC	PREALT
		USERPREAC	PREALT
		DBP_MSG_INTRPRT	PREALT
FRAME_FMT_UPDATE	DCMOW	MASTER_FRAME	DCMOW
FREEZE_DISPLAY	FP	FORMAT_FREQ_FP	FP
		DC_HOME_FREQ_FP	FP
		KG_TIME_FP	FP
		KG_MEM_CHANGE_FP	FP
FREQ_CODE_CHK_5	FP	KG_TIME_FP	FP
FREQ_CODE_CHK_FP	FP	FORMAT_FREQ_FP	FP
		DC_HOME_FREQ_FP	FP
FREQ_TO_DSPLY_FP	FP	FORMAT_FREQ_FP	FP
FSLOT	STPV06	SRX	STPV06
GET_RANDOM_NR_GS	GS	RCOW_PREP_XMIT	PREALT
		COMP_RRU_PREC	PREINT

Module Name	Located in	Is Called by	Located in
GET_RCOW_ADR_GS	GS	DATA_XFER	DCMOW
		INFO_REQUEST	DCMOW
		ANY_MSG_IN_QUE	DCMOW
		FRAME_CHK_PRECLA	PRECLA
		RRU_STATUS_RPTB	PREINT
		DATA_XFER	PREINT
		CALL_COMPLETE	PREINT
		RRU_PRTY_OUT_05	PREINT
		INFO_REPORT_05	PREINT
		RRU_CALLCAN_05	PREINT
		RRU_CALL_CAN_15	PREINT
		PAGING_05	PREINT
		FIND_RRU_QUE	PREINT
		ANY_MSG_IN_QUE	PREINT
		CONFIR_LIST_RTP	PREINT
		DEDICATED_SLOT	PREINT
		CLRTIM	PREINT
		CALL_REQ_05	PREINT
		CONF_REQ_05	PREINT
GET_RRU_INADR_GS	GS	RRU_INTRPRT	DCMOW
		CALL_REQUEST	DCMOW
		DATA-XFER	DCMOW
		GLIST_DISP	DCMOW
		CALL_COMPLETE	DCMOW
		INFO_REQUEST	DCMOW
		RRU_INTRPRT	PREINT
		CONF_REQUEST	PREINT
		CALL_REQUEST	PREINT
		RRU_STATUS_RPTB	PREINT
		DATA_XFER	PREINT
		GLIST_DISPLAY	PREINT
		CALL_COMPLETE	PREINT
		RRU_PRTY_OUT_05	PREINT
		INFO_REPORT	PREINT
		RRU_CALL_CANCEL	PREINT
		GLIST_ENTR_DEL	PREINT
		GLIST_ENTDEL_05	PREINT
		PAGING_RCOW	PREINT
		CONFIG_ENTRY	PREINT
GET_TIME_CODE	FP	OUT_OF_SERV_FP	FP
		CONFER_CALL_FP	FP
GLIST_COMPARE	PREINT	GLIST_DISP_05	PREINT
		CHK_GLIST	PREINT
GLIST_COUNTER	PREINT	ENTER_GUARD_LIST	PREINT
		GLIST_ENTDEL_10	PREINT
		GLIST_ENTDEL_30	PREINT
		DELET_GUARD_LIST	PREINT
HI_GUARD_CHK_FP	FP	ZEROIZE_FP	FP
		INFO_REPORT_FP	FP
		TO_PARITY_CALL_FP	FP
		CONFER_CALL_FP	FP
		INFO_REQUEST_FP	FP
		GLIST_ENTER_FP	FP
		PAGING_REQ_FP	FP
IN_CCOW_FROM_DBP	DCEXEC	DBP_MSG_INTRPRT	DCEXEC
		DBP_MSG_INTRPRT	PREALT

Module Name	Located in	Is Called by	Located in
INFO_REPORT_FP	FP	CALL_CC_GS	GS
INFO_REQ_05_GS	GS	HOME_CHAN_05	PREINT
INFO_REQ_CHK_45	FP	SELECT_PORT_FP	FP
INFO_REQ_CHK_50	FP	PORT_RELEASE_FP	FP
INFO_REQ_CHK_FP	FP	FPANEL	FP
INIT	PREALT/DBPV4 (LABEL)	PWRON	DBPV4
		TDMA	DBPV4
INITIAL_ENTRY	PREINT	RRU_STATUS_RPTB	PREINT
		DATA_XFER	PREINT
		CALL_COMPLETE	PREINT
		RRU_PRTY_OUT_05	PREINT
		INFO_RPT_05	PREINT
		RRU_CALL_CAN_15	PREINT
		PAGING_05	PREINT
		STATUS_RPT_A	PREINT
		LINK_RESULT	PREINT
		FORMAT_GLIST_RCW	PREINT
		CALL_REQ_05	PREINT
		CONF_REQ_05	PREINT
IO1LF	DBPV4	IO1A	DBPV4
IO1LS	DBPV4	IO1A	DBPV4
IO2LF	DBPV4	IO2A	DBPV4
IO2LS	DBPV4	IO2A	DBPV4
IO3LF	DBPV4	IO3A	DBPV4
IO3LS	DBPV4	IO3A	DBPV4
IO4LF	DBPV4	IO4A	DBPV4
IO4LS	DBPV4	IO4A	DBPV4
JUMP_COMPLETE_GS	GS	DCKPORTOFF_GS	GS
JUMP_SELECT_1_GS	GS	DCKPORTOFF_GS	GS
		SHOW_PORT_GS	GS
		CALL_CC_GS	GS
JUMP_SELECT_2_GS	GS	DCKPORTOFF_GS	GS
		SHOW_PORT_GS	GS
		CALL_CC_GS	GS
KB_TIME_INIT_GS	GS	ZEROIZE_FP	FP
		OUT_OF_SERV_FP	FP
		STATUS_RPT_B_FP	FP
		GLIST_DISPLY_FP	FP
		LINK_TEST_REQ_FP	FP
		INFO_REQUEST_FP	FP
		TO_PARITY_CALL_FP	FP
		CONFER_CALL_FP	FP
		CALL_CANCEL_FP	FP
		INFO_REQUEST_FP	FP
		GLIST_ENTER_FP	FP
		PAGING_REQ_FP	FP
		CONFIG_CODE_FP	FP
		CALL_COMPLETE_FP	FP
KG_INITIAL_GS	GS	EXEC_DCEXEC	DCEXEC
		EXEC_PREALT	PREALT
		ENCRYPT_CCOW	PREALT

Module Name	Located in	Is Called by	Located in
KG_INITIAL_GS_05	GS	ENCRYPT_CCOW	DCEXEC
		DECRYPT_CCOW	DCEXEC
		DECRYPT_RCOW_GS	GS
		ENCRYPT_RCOW_GS	GS
		ENCRYPT_CCOW	PREALT
		DECRYPT_CCOW	PREALT
KG_LOAD_GS	GS	USERPREAC	DCEXEC
		ENCRYPT_CCOW	DCEXEC
		USERPREAC	PREALT
KG_MEM_CHANGE_GS	GS	EXEC_DCEXEC	DCEXEC
		TS_PREP_DCEXEC	DCEXEC
		EXEC_PREALT	PREALT
		TS_PREP_PREALT	PREALT
		KG_LOAD_GS	GS
KG_MEM_FILL_20	FP	KG_MEM_FILL_FP	FP
KG_MEM_FILL_FP	FP	FPANEL	FP
KG_MEM_TEST_GS	GS	EXAM_CCOW_OVRHED	PRECLA
		KG_MEM_CHANGE_GS	GS
KG_READY_GS	GS	EXAM_CCOW_OVRHED	PRECLA
		KG_RESET_GS	GS
		KG_INITIAL_GS	GS
KG_RESET_GS	GS	EXEC_DCEXEC	DCEXEC
		TS_PREP_DCEXEC	DCEXEC
		ENCRYPT_CCOW	DCEXEC
		DECRYPT_CCOW	DCEXEC
		DECRYPT_RCOW_GS	GS
		ENCRYPT_RCOW_GS	GS
		KG_MEM_CHANGE_GS	GS
		EXEC_PREALT	PREALT
		TS_PREP_PREALT	PREALT
		ENCRYPT_CCOW	PREALT
		DECRYPT_CCOW	PREALT
KG_TIME_75	FP	KG_TIME_FP	FP
KG_TIME_TO_DSPLY	FP	KG_TIME_FP	FP
KG_ZEROIZE_GS	GS	STATUS_DCCNTR	DCCNTR
		STATUS_PRECLA	PRECLA
LD1	DBPV4	IO1A	DBPV4
LD2	DBPV4	IO2A	DBPV4
LD3	DBPV4	IO3A	DBPV4
LD4	DBPV4	IO4A	DBPV4
LITES_OFF_DCMOW	DCMOW	STATUS_DCCNTR	DCCNTR
		ZEROIZE	DCMOW
		FRAME_FMT_UPDATE	DCMOW
		CHAN_CONTROL_FP	FP
LITES_OFF_GS	GS	RECALL_FP	FP
		INFO_REQUEST_FP	FP
		PORT_RELEASE_FP	FP
		INFO_REQ_CHK_FP	FP
		CALL_COMPLETE_FP	FP
		LINK_TEST_REQ_FP	FP
		ZEROIZE_FP	FP
		STATUS_RPT_B_FP	FP
		GLIST_DISPLY_FP	FP
		CHAN_CONTROL_FP	FP
		OUT_OF_SERV_FP	FP

Module Name	Located in	Is Called by	Located in
LITES_OFF_PREINT	PREINT	STATUS_PRECLA	PRECLA
		FORMAT_UPDATE	PREINT
		NUFMT_TO_STP	PREINT
LNK_TST_LAMP_GS	GS	TO_PARITY_CALL_FP	FP
		FORMAT_FREQ_FP	FP
		PORT_RELEASE_FP	FP
		DC_HOME_FREQ_FP	FP
		AC_HOME_FREQ_FP	FP
		QUEUE_TIME_FP	FP
		SELECT_PORT_FP	FP
		CONFER_CALL_FP	FP
		KG_TIME_FP	FP
		CALL_CANCEL_FP	FP
		INFO_REQUEST_FP	FP
		GLIST_ENTER_FP	FP
		PAGING_REQ_FP	FP
		EXTEND_XMIT_FP	FP
		KG_MEM_CHANGE_FP	FP
		GLIST_DELETE_FP	FP
		STG_CONTROL_FP	FP
		CONFIG_CODE_FP	FP
		LAMP_TEST_GS	GS
LO_GUARD_CHK_FP	FP	GLIST_ENTER_FP	FP
LOAD_KG_VARS_GS	GS	ENCYRPT_CCOW	DCEXEC
		DECRYPT_CCOW	DCEXEC
		DECRYPT_RCOW_GS	GS
		ENCRYPT_RCOW_GS	GS
		ENCRYPT_CCOW	PREALT
		DECRYPT_CCOW	PREALT
LTRXEX	STPV06	EXEC	STPV06
MASTER_FRA_05	PREINT	MASTER_FRAME	PREINT
MASTER_FRA_10	PREINT	MASTER_FRAME	PREINT
MASTER_FRAME	DCMOW/PREINT/DCCNTR	CCOW_INTP_DCMOW	DCMOW
		CCOW_INTP_PREINT	PREINT
MOVE_FRAME_GS	GS	MASTER_FRAME	DCCNTR
		FRAME_CHK_DCCNTR	DCCNTR
MOVE_GS	GS	SPECIAL_CCOW	DCCNTR
		RCOW_INTP_DCCNTR	DCCNTR
		INIT_DCEXEC	DCEXEC
		MOVE_TMP_TO_VARS	DCEXEC
		MOVE_VARS_TO_TMP	DCEXEC
		STP_MSG_INTRPRT	DCEXEC
		INIT	PREALT
		MOVE_VARS_TO_TMP	PREALT
		MOVE_TMP_TO_VARS	PREALT
		STP_MSG_INTRPRT	PREALT
		RCOW_INTP_PRECLA	PRECLA
MOVE_TMP_TO_VARS	DCEXEC/PREALT	USERPREAC	PREALT
		USERPREAC	DCEXEC
MOVE_VARS_TO_TMP	DCEXEC/PREALT	USERPREAC	DCEXEC
		USERPREAC	PREALT
NET_NUM_XCHNG	DCEXEC	DECRYPT_CCOW	DCEXEC
NUFMT_TO_STP	PREINT	MASTER_FRAME	PREINT
		FORMAT_CHANGE	PREINT
ODD_PORT_STORE	PREINT	RRU_STATUS_RPTB	PREINT

Module Name	Located in	Is Called by	Located in
OFFSET_BY_3_GS	GS	CC_EXEC_DCCNTR	DCCNTR
		COMMAND_FRAME	DCMOW
OFFSET_BY_6_GS	GS	CC_EXEC_DCCNTR	DCCNTR
		COMMAND_FRAME	DCMOW
OUT_SVC_UPDATE	PREINT	USER_OUT_ACK	PREINT
		PART_OUT_OF_SVC	PREINT
PLACE_CALL_PRTY	PREINT	CONF_REQ_05	PREINT
PLACE_PORT	PREINT	CONFER_LIST_RPT	PREINT
		STATUS_RPT_B	PREINT
POINT_TO_GLIST1	PREINT	SET_GLIST_PTR	PREINT
POINT_TO_GLIST2	PREINT	SET_GLIST_PTR	PREINT
POINT_TO_GLIST3	PREINT	SET_GLIST_PTR	PREINT
POINT_TO_GNUM	PREINT	POINT_TO_GLIST1	PREINT
		POINT_TO_GLIST2	PREINT
		POINT_TO_GLIST3	PREINT
PORT_DETECT_GS	GS	DBP_MSG_INTRPRT	DCEXEC
PORT_DISCO_UPDATE	PREINT	RRU_UPDATE	PREINT
		ZEROIZE	PREINT
PORT_DISCONNECT	DCMOW	FRAME_FMT_UPDATE	DCMOW
		FORMAT_UPDATE	PREINT
		NUFMT_TO_STP	PREINT
PORT_RELEASE_15	FP	FPANEL	FP
PORT_RELEASE_FP	FP	DCKPORTOFF_GS	GS
		SHOW_PORT_GS	GS
		CALL_CC_GS	GS
PORTCCADR_05	PREINT	CONFIG_ENTRY_05	PREINT
PORTCCADR_PREINT	PREINT	CONFIG_CODE_FP	FP
		SLOT_CON_UPDATE	PREINT
		RRU_STATUS_RPTB	PREINT
		CALL_REQ_05	PREINT
		CONF_REQ_05	PREINT
		CONFIG_ENTRY_05	PREINT
PRE_DCKA_CHK_FP	FP	TO_PARTY_CALL_FP	FP
PREC_CONVERT_FP	FP	FPANEL	FP
		TO_PARITY_CALL_FP	FP
PREC_ENTER_25	FP	FORMAT_FREQ_FP	FP
PREC_ENTER_30	FP	GLIST_DISPLY_FP	FP
PREC_ENTER_FP	FP	OUT_OF_SERV_FP	FP
		TO_PARITY_CALL_FP	FP
		CONFER_CALL_FP	FP
PREC_TO_RCOW_GS	GS	DATA_XFER	DCMOW
		DATA_XFER	PREINT
		RRU_PRTY_OUT	PREINT
		CALL_REQ_05	PREINT
		CONF_REQ_05	PREINT
PREEMPT_LITE	PRINT	RRU_DISCO	PREINT
PREEMPT_UPDATE	PRECLA	TIME_CHK_PRECLA	PRECLA
PREMPTCOUNT_05	PREINT	PREMPTCOUNT_REDO	PREINT
PREMPTCOUNT_REDO	PREINT	SLOT_CON_UPDATE	PREINT
		SLOT_DISCONNECT	PREINT
		CALL_COMPLETE	PREINT
PRSN	STPV06	SRX	STPV06
PRT_CNFIG_CHNG	PREINT	RRU_STATUS_RPTB	PREINT
PSA	STPV06	EXEC	STPV06
		CONFIG	STPV06
PTSN	STPV06	STX	STPV06

Module Name	Located in	Is Called by	Located in
PVR	STPV06	SRX	STPV06
		BRX	STPV06
PVRA	STPV06	SRX	STPV06
PVT	STPV06	STX	STPV06
		BTX	STPV06
RAMT	DBPV4/STPV06	COLDS	STPV06
RCCOW_PORTADR_GS	GS	DATA_XFER	DCMOW
		INFO_REPORT	DCMOW
		RRRU_STATUS_RPTB	PREINT
		DATA_XFER	PREINT
		CALL_COMPLETE	PREINT
		RRU_PRTY_OUT_05	PREINT
		INFO_RPT_05	PREINT
		RRU_CALLCAN_15	PREINT
		PAGING_05	PREINT
		STATUS_RPT_A	PREINT
		LINK_RESULT	PREINT
		CALL_REQ_05	PREINT
		CONF_REQ_05	PREINT
RCOW_ASSIGN_FMT	PREINT	CALL_ACK_05	PREINT
		RCOW_ASSIGN_05	PREINT
RCOW_INTP_DCCNTR	DCCNTR	USEREXEC	DCEXEC
RCOW_INTP_PRECLA	PRECLA	USEREXEC	PREALT
RCOW_OUT_PREINT	PRINT	USEREXEC	PREALT
RCOW_PREP_XMIT	DCEXEC/PREALT	USEREXEC	DCEXEC
		USEREXEC	PREALT
RCOW_XMIT_DCMOW	DCMOW	USEREXEC	DCEXEC
RCV_CCOW_BLOCK	PRECLA	CC_EXEC_PRECLA	PRECLA
READ_ACIA	GS	TEST_ACIA	GS
READ_CALL_ACK	PREINT	MASTER_FRAME	PREINT
		COMMAND_FRAME	PREINT
READ_DBP_RCOW_GS	GS	DBP_MSG_INTRPRT	DCEXEC
		DBP_MSG_INTRPRT	PREALT
REDO_DBP_PORT_GS	GS	DISCO_SLOT_CHK	DCMOW
		CALL_REQUEST	DCMOW
		CALL_COMPLETE	DCMOW
		INIT	PREALT
		RRU_TURNOFF	PRECLA
		SLOT_CON_UPDATE	PREINT
		PORT_DISCONNECT	PREINT
		CLEAR_SLOTS_GS	GS
REDO_RRU1_GS	GS	REDO_RRUS_DCMOW	DCMOW
		REDO_RRUS_PREINT	PREINT
		WRITE_ACIA	GS
REDO_RRU2_GS	GS	REDO_RRUS_DCMOW	DCMOW
		REDO_RRUS_PREINT	PREINT
		WRITE_ACIA	GS
REDO_RRU3_GS	GS	REDO_RRUS_DCMOW	DCMOW
		REDO_RRUS_PREINT	PREINT
		WRITE_ACIA	GS
REDO_RRU4_GS	GS	REDO_RRUS_DCMOW	DCMOW
		REDO_RRUS_PREINT	PREINT
		WRITE_ACIA	GS
REDO_RRUS_DCMOW	DCMOW	USEREXEC	DCEXEC
		CCOW_INTP_DCMOW	DCMOW

Module Name	Located in	Is Called by	Located in
REDO_RRUS_PREINT	PREINT	USEREXEC	PREALT
		CCOW_INTP_PREINT	PREINT
REINIT_DELAY	DCMOW	MASTER_FRAME	DCMOW
RESET_ACIAS_GS	GS	INIT_DCEXEC	DCEXEC
		INIT	PREALT
RESET_BLACK_GS	GS	ENCRYPT_CCOW	DCEXEC
		DECRYPT_CCOW	DCEXEC
		DECRYPT_RCOW_GS	GS
		ENCRYPT_RCOW_GS	GS
		KG_INITIAL_GS	GS
		DECRYPT_CCOW	PREALT
		ENCRYPT_CCOW	PREALT
RESET_RRU_PTR_GS	GS	RRU_INTRPRT	DCMOW
		CALL_REQUEST	DCMOW
		DATA_XFER	DCMOW
		GLIST_DISP	DCMOW
		CALL_COMPLETE	DCMOW
		INFO_REPORT	DCMOW
		RRU_INTRPRT	PREINT
		RRU_STATUS_RPTB	PREINT
		DATA_XFER	PREINT
		GLIST_DISPLAY	PREINT
		GLIST_DISPLAY_05	PREINT
		CALL_COMPLETE	PREINT
		RRU_PRTY_OUT	PREINT
		INFO_REPORT	PREINT
		INFO_REPORT_05	PREINT
		CALL_REQUEST	PREINT
		CALL_REQ_05	PREINT
		CONF_REQUEST	PREINT
		RRU_CALL_CANCEL	PREINT
		RRU_CALLCAN_05	PREINT
		GLIST_ENTR_DEL	PREINT
		GLIST_ENTDEL_05	PREINT
		GLIST_ENTDEL_10	PREINT
		PAGING_RCOW	PREINT
		PAGING_05	PREINT
		CONF_REQ_05	PREINT
		CONFIG_ENTRY	PREINT
RGRXEX	STPV06	EXEC	STPV06
ROMTST	DBPV4	PWRON	DBPV4
RPT_B_OUT_PREINT	PREINT	FP_RCOW	PREALT
		STATUS_RPT_B	PREINT
RQST_CODE_GS	GS	INFO_REPORT	DCMOW
		FPANEL	FP
		INFO_REPORT_FP	FP
		INFO_REQUEST_GS	GS
		INFO_RPT_05	PREINT

Module Name	Located in	Is Called by	Located in
RRU_ACPT_ON_GS	GS	DATA_XFER	DCMOW
		CALL_REQUEST	DCMOW
		CALL_COMPLETE	DCMOW
		INFO_REPORT	DCMOW
		RRU_STATUS_RPTB	PREINT
		DATA_XFER	PREINT
		CALL_COMPLETE	PREINT
		RRU_PRTY_OUT_05	PREINT
		INFO_RPT_05	PREINT
		RRU_CALLCAN_I5	PREINT
		PAGING_05	PREINT
		CALL_REQ_05	PREINT
		CONF_REQ_05	PREINT
RRU_B2_LOOP_CHK	DCEXEC/PREALT	RCOW_PREP_XMIT	DCEXEC
		RCOW_PREP_XMIT	PREALT
RRU_CLEAR_BIT_GS	GS	STP_MSG_INTRPRT	DCEXEC
		CLR_RRU_PREC_DSP	DCEXEC
		FPANEL	FP
		CLR_RRU_PREC_DSP	PREALT
		STP_MSG_INTRPRT	PREALT
		MASTER_FRAME	PREINT
RRU_DISCO	PREINT	CHK_USER_NR1	PREINT
		CHK_USER_NR2	PREINT
RRU_INTRPRT	DCMOW/PREINT	RRU_MSG_IN_DCMOW	DCMOW
		RRUMSG_IN_PREINT	PREINT
RRU_MSG_IN_DCMOW	DCMOW	USERPREAC	DCEXEC
RRU_MSG_UPDATE	PREALT	USEREXEC	DCEXEC
		USERPREAC	DCEXEC
		USEREXEC	PREALT
		USERPREAC	PREALT
RRU_OUT_ADR	PREINT	BUSY_ACK	PREINT
		CALL_ACK	PREINT
RRU_SET_BIT_GS	GS	STP_MSG_INTRPRT	DCEXEC
		RRU_MSG_UPDATE	DCEXEC
		FPANEL	FP
		STP_MSG_INTRPRT	PREALT
		RRU_MSG_UPDATE	PREALT
		MASTER_FRAME	PREINT
RRU_TURNOFF	PRECLA	TIME_CHK_PRECLA	PRECLA
RRU_XMIT_SET_GS	GS	USEREXEC	DCEXEC
		USERPREAC	DCEXEC
		USEREXEC	PREALT
		USERPREAC	PREALT
RRUMSG_IN_PREINT	PREINT	USEREXEC	PREALT
		USERPREAC	PREALT
RRUOUTAD2_PREINT	PREINT	FRAME_CHK_PRECLA	PRECLA
		BUSY_ACK	PREINT
		CALL-ACK_05	PREINT
		CALL_ACK	PREINT
SAVE_STPI1_GS	GS	DISCO_SLOT_CHK	DCMOW
		INIT	PREALT
		RRU_TURNOFF	PRECLA
		SLOT_CON_UPDATE	PREINT
		PORT_DISCONNECT	PREINT

Module Name	Located in	Is Called by	Located in
SAVE_STP12_GS	GS	SWITCH_REDO	DCEXEC
		AC_HOME_FREQ_FP	FP
		EXEC_PREALT	PREALT
		USEREXEC	PREALT
		EXAM_CCOW_OVRHED	PRECLA
		HOME_CHAN_05	PREINT
SAVE_STP13_GS	GS	TIME_CHK_DCCCNTR	DCCNTR
		EXEC_DCEXEC	DCEXEC
		USEREXEC	DCEXEC
		STP_MSG_INTRPRT	DCEXEC
		MASTER_FRAME	DCMOW
		SETUP	PREALT
		USERPREAC	PREALT
		STP_MSG_INTRPRT	PREALT
		EXAM_CCOW_OVRHED	PRECLA
		STATUS_PRECLA	PRECLA
		CC_EXEC_PRECLA	PRECLA
SAVE_STP18_GS	GS	TIME_CHK_DCCCNTR	DCCNTR
		STATUS_DCCNTR	DCCNTR
		USEREXEC	DCEXEC
		USERPREAC	DCEXEC
		STP_MSG_INTRPRT	DCEXEC
		MASTER_FRAME	DCMOW
		RCOW_XMIT_DCMOW	DCMOW
		USEREXEC	PREALT
		STP_MSG_INTRPRT	PREALT
		EXAM_CCOW_OVRHED	PRECLA
		TIME_CHK_PRECLA	PRECLA
		STATUS_PRECLA	PRECLA
		RCOW_OUT_PREINT	PREINT
		MASTER_FRAME	PREINT
		LINK_TEST_ASIGN	PREINT
SAVE_SW3_GS	GS	SETUP_MISC	DCEXEC
		AC_HOME_FREQ_FP	FP
		INIT	PREALT
		SETUP	PREALT
		EXAM_CCOW_OVRHED	PRECLA
		HOME_CHAN_05	PREINT
SCCNV	STPV06	EXEC	STPV06
SEL_PORT_DISCO	PREINT	SLOT_DISCONNECT	PREINT
		RRU_DISCO	PREINT
		SLOT_CON_UPDATE	PREINT
		CALL_COMPLETE	PREINT
SELECT_PORT_FP	GP	JUMP_SELECT_1_GS	GS
		JUMP_SELECT_2_GS	GS
SEND_CCOW_BLOCK	PRECLA	CC_EXEC_PRECLA	PRECLA
SEND_RCOW_TO_SAC	PRECLA	CC_EXEC_PRECLA	PRECLA
SEQUENCE_LITES	DCCNTR	FRAME_CHK_DCCNTR	DCCNTR
SET_DBPSTAT_MSG	DCCNTR/PRECLA	STATUS_DCCNTR	DCCNTR
		STATUS_PRECLA	PRECLA
SET_GLIST_FLAG	PREINT	GLIST_ENTDEL_10	PREINT
		GLIST_ENTDEL_30	PREINT
SET_GLIST_PNTR	PREINT	RPT_GLIST1	PREINT
		RPT_GLIST2	PREINT
		RPT_GLIST3	PREINT
		RPT_GLIST4	PREINT

Module Name	Located in	Is Called by	Located in
SET_MSG_CODE	PREINT	RPT_GLIST1	PREINT
		RPT_GLIST2	PREINT
		RPT_GLIST3	PREINT
		RPT_GLIST4	PREINT
SET_PORT_CC	DCCNTR/PRECLA	STATUS_DCCNTR	DCCNTR
		STATUS_PRECLA	PRECLA
SET_PREMPT_FLAG	PREINT	RRU_DISCO	PREINT
		SLOT_CON_UPDATE	PREINT
SET_SC_FLAG	PREINT	SET_XMIT_FLAG	PREINT
SET_TIME_CODE	PREINT	RRU_DISCO	PREINT
		SLOT_CON_UPDATE	PREINT
SETUP	DBPV4/STPV06	INIT	PREALT
SETUP_MISC	DCEXEC/PREALT	INIT_DCEXEC	DCEXEC
SETUP1	DBPV4/DCMOW	PWRON	DBPV4
		TDMA	DBPV4
SHIFT_EVEN_PORT	PREINT	STATUS_RPT_A	PREINT
SHIFT_ODD_PORT	PREINT	STATUS_RPT_A	PREINT
SHIFTLEFT	GS	LOAD_KG_VARS_GS	GS
SHIFTRIGHT	GS	LOAD_KG_VARS_GS	GS
SHOW_PORT_GS	GS	PORT_DETECT_GS	GS
SHOW_WX_GS	GS	KG_TIME_TO_DSPLY	FP
		DISP_VWXYZ_GS	GS
SHOW_YZ_GS	GS	BCD_TO_YZ_FP	FP
		AC_HOME_FREQ_FP	FP
		KG_TIME_TO_DSPLY	FP
		DISP_VWXYZ_GS	GS
		DISP_INFO_REQ_GS	GS
SHOWOUT_YZ_GS	GS	FPANEL	FP
		CONFIG_CODE_FP	FP
SLOT_CON_UPDATE	PREINT	SLOT_CONNECT	PREINT
SOFA	DBPV4	SOF	DBPV4
SOFAA	DBPV4	RBIT	DBPV4
SRX	STPV06	CONS	STPV06
SST	STPV06	RCW1	STPV06
		RR2	STPV06
STATUS_DCCNTR	DCCNTR	EXEC_DCEXEC	DCEXEC
STATUS_PRECLA	PRECLA	EXEC_PREALT	PREALT
STC	STPV06	CONFIG_CODE_FP	STPV06
STC4	STPV06	STC	STPV06
STG_LITE_UPDATE	FP	STG_CONTROL_FP	FP
STP_MSG_INTRPRT	DCEXEC/PREALT	USEREXEC	DCEXEC
		USERPREAC	DCEXEC
		USEREXEC	PREALT
		USERPREAC	PREALT
STRAP_05	GS	STRAP_READ_GS	GS
STRAP_READ_GS	GS	INIT_DCEXEC	DCEXEC
		SETUP_MISC	DCEXEC
		INIT	PREALT
STUFF	DBPV4	TDMA	DBPV4
STX	STPV06	CONS	STPV06
SUB_KG_TIME_GS	GS	PORT_DETECT_GS	GS
SWAPLITES_DCEXEC	DCEXEC	EXEC_DCEXEC	DCEXEC
		USEREXEC	DCEXEC
		STP_MSG_INTRPRT	DCEXEC
		MASTER_FRAME	DCMOW
		CHAN_CONTROL_FP	FP

Module Name	Located in	Is Called by	Located in
SWITCH_REDO	DCEXEC	EXEC_DCEXEC	DCEXEC
SWITCHIT_GS	GS	EXEC_DCEXEC	DCEXEC
		SWITCH_REDO	DCEXEC
		EXEC_PREALT	PREALT
TEST_ACIA	GS	INTERUPT_GS	GS
TIME_CHK_DCCNTR	DCCNTR	USEREXEC	DCEXEC
		USERPREAC	DCEXEC
TIME_CHK_PRECLA	PRECLA	USEREXEC	PREALT
		USERPREAC	PREALT
TIME_DELAY	DCMOW/PREINT	INFO_REPORT	DCMOW
		RRU_STATUS_RPTB	PREINT
		PAGING_05	PREINT
		INFO_RPT_05	PREINT
		CALL_COMPLETE	PREINT
TIME_FMT	PREINT	RRU_DISCO	PREINT
		SLOT_CON_UPDATE	PREINT
		CALL_QUE_UPDATE	PREINT
		PORT_DISCO_UPDATE	PREINT
TS_PREP_DCEXEC	DCEXEC	FRAME_CHK_DCCNTR	DCCNTR
		USERPREAC	DCEXEC
TS_PREP_PREALT	PREALT	USERPREAC	PREALT
		FRAME_CHK_PRECLA	PRECLA
TST_XMITD_QUE	PREINT	BUSY_ACK	PREINT
		READ_CALL_ACK	PREINT
UNPACK_GS	GS	FPANEL	FP
		INFO_REQ_CHK_FP	FP
		FREQ_TO_DSPLY_FP	FP
		CONFIG_CODE_FP	FP
		SHOW_YZ_GS	GS
		SHOW_WX_GS	GS
USER1_SETUP_GS	GS	ZEROIZE	DCMOW
		INFO_REQUEST_GS	GS
		SLOT_DISCONNECT	PREINT
		PARTY_OUT_OF_SVC	PREINT
		USER1_SETUP_GS	PREINT
		ZEROIZE	PREINT
		CCOW_DATA_XFER	PREINT
		CALL_IN_QUE	PREINT
		CALL_WAITING	PREINT
		DELET_GUARD_LIST	PREINT
		ENTER_GUARD_LIST	PREINT
		HOME_CHAN_CHANG	PREINT
		CALL_CANCEL	PREINT
		FORMAT_CHANGE	PREINT
		SLOT_CONNECT	PREINT
		LINK_TEST_ASIGN	PREINT

Module Name	Located in	Is Called by	Located in
USER2_SETUP	PREINT	ZEROIZE	DCMOW
		SLOT_DISCONNECT	PREINT
		SLOT_CONNECT	PREINT
		FORMAT_CHANGE	PREINT
		CALL_CANCEL	PREINT
		HOME_CHAN_CHANG	PREINT
		ENTER_GUARD_LIST	PREINT
		DELET_GUARD_LIST	PREINT
		CALL_IN_QUE	PREINT
		ZEROIZE	PREINT
		PARTY_OUT_OF_SVC	PREINT
USER3_SETUP	PREINT	CALL_CANCEL	PREINT
		HOME_CHAN_CHANG	PREINT
		ENTER_GUARD_LIST	PREINT
		DELET_GUARD_LIST	PREINT
USEREXEC	DCEXEC/PREALT	EXEC_DCEXEC	DCEXEC
		EXEC_PREALT	PREALT
USERPREAC	DCEXEC/PREALT	EXEC_DCEXEC	DCEXEC
		EXEC_PREALT	PREALT
VWXYZ_TO_BIN_FP	FP	ZEROIZE_FP	FP
		GLIST_DELETE_FP	FP
		PAGING_REQ_FP	FP
		GLIST_ENTER_FP	FP
		INFO_REPORT_FP	FP
		TO_PARITY_CALL_FP	FP
		CONFER_CALL_FP	FP
WRITE_ACIA	GS	TEST_ACIA	GS
WX_TO_BCD_FP	FP	KG_TIME_FP	FP
		INFO_REQUEST_FP	FP
XFER_CCOW_TO_DBP	DCEXEC	EXEC_DCEXEC	DCEXEC
XFER_OW	PREALT	EXEC_PREALT	PREALT
XFER_RCOW_DBP_GS	GS	EXEC_DCEXEC	DCEXEC
		RCOW_PREP_XMIT	DCEXEC
		RCOW_PREP_XMIT	PREALT
XPLUSA_GS	GS	FRAME_CHK_DCCNTR	DCCNTR
		CALL_REQUEST	DCCNTR
		SEQUENCE_LITES	DCCNTR
		RCOW_INTP_DCCNTR	DCCNTR
		RRU_B2_LOOP_CHK	DCEXEC
		SWAPLITES_DCEXEC	DCEXEC
		CALL_REQUEST	DCMOW
		INFO_REQ_CHK_FP	FP
		INIT	PREALT
		RRU_B2_LOOP_CHK	PREALT
		RCOW_INTP_PRECLA	PRECLA
		FORMAT_GLIST_RCW	PREINT
		MASTER_FRAME	PREINT
		RRU_DISCO	PREINT
		CHK_GLIST	PREINT
		XPLUSB_GS	GS
		RRU_CLEAR_BIT_GS	GS
		RRU_SET_BIT_GS	GS

Module Name	Located in	Is Called by	Located in
XPLUSB_GS	GS	FORMAT_FREQ_FP	FP
		DC_HOME_FREQ_FP	FP
		FREQ_TO_DSPLY_FP	FP
		CALL_COMPLETE	DCMOW
		CALL_REQUEST	DCMOW
		BIT_RATE_FIND	DCMOW
YZ_TO_BCD_FP	FP	OUT_OF_SERV_FP	FP
		DC_HOME_FREQ_FP	FP
		KG_TIME_FP	FP
		INFO_REQUEST_FP	FP
YZ_TO_BIN_FP	FP	CONFER_CALL_FP	FP
ZERO_SLOTS_GS	GS	STATUS_DCCNTR	DCCNTR
		ZEROIZE	DCMOW

Module Name	Located in	Is Called by	Located in
ZEROFILL_GS	GS	SPECIAL_CCOW	DCCNTR
		TIME_CHK_DCCNTR	DCCNTR
		STATUS_DCCNTR	DCCNTR
		EXEC_DCEXEC	DCEXEC
		STP_MSG_INTRPRT	DCEXEC
		RCOW_XMIT_DCMOW	DCMOW
		CHAN_CONTROL_FP	FP
		EXEC_PREALT	PREALT
		STP_MSG_INTRPRT	PREALT
		TIME_CHK_PRECLA	PRECLA
		STATUS_PRECLA	PRECLA
		MASTER_FRAME	PREINT
		CONF_REQ_05	PREINT
		REDO_RRU1_GS	GS
		CLEAR_SLOTS_GS	GS

APPENDIX C

A. PARSER.ADA

```
with text_io; use text_io;
procedure parser is

  package int_io is new integer_io(integer);
  use int_io;

  subtype label_range is integer range 1..6;
  subtype opcode_range is integer range 8..13;
  subtype operand_range is integer range 15..20;

  subtype str6  is string(1..6);
  subtype str120 is string(1..120);

  type call_node;
  type call_node_ptr is access call_node;

  type call_node is record
    caller : integer;
    next   : call_node_ptr;
  end record;

  type label_node;
  type label_node_ptr is access label_node;

  type label_node is record
    label     : str6;
    called_by : call_node_ptr;
    line      : integer;
    next      : label_node_ptr;
  end record;

  label_list   : label_node_ptr := null;
  new_label    : label_node_ptr;
  search       : label_node_ptr;
  label        : str6;
  opcode       : str6;
  operand      : str6;
  col_nbr      : natural;
  new_caller   : call_node_ptr;
  input_file   : file_type;
  output_file  : file_type;

  procedure establish_label_list is
    line     : str120;
    line_nbr : integer := 0;
    count    : natural;
    debug    : boolean := false;
    found    : boolean;
  begin
    while not end_of_file(input_file) loop
```

```
    get_line(input_file, line, count);
    line_nbr := line_nbr + 1;
    put(output_file,line_nbr,4);
    put_line(output_file," " & line(1..count));
    -- CHECK IF THE LINE HAS A LABEL
    if count > 0 then
      if line(1) >= 'A' and line(1) <= 'Z' then
        if count >= 7 then
          label := line(label_range);
          if debug then put_line("LABEL IS " & label); end if;

          -- CHECK AND SEE IF THE LABEL EXISTS
          search := label_list;
          found  := false;
          while search /= null loop
            if search.label = label then
              found := true;
            end if;
            search := search.next;
          end loop;
          if debug then put_line("SEARCHED FOR LABEL - " &
             boolean'image(found)); end if;
          if not found then
            -- ENTER THE LABEL INTO THE END OF THE LINKED LIST
            new_label       := new label_node;
            new_label.label := label;
            new_label.next  := null;
            new_label.line  := line_nbr;
            search := label_list;
            if search = null then
              -- FIRST ITEM IN THE LIST
              label_list := new_label;
            else
              while search.next /= null loop
                search := search.next;
              end loop;
              search.next := new_label;
            end if;
          end if;
        end if; -- count > 7
      end if; -- 'A' or 'Z'
    end if; -- count > 0
  end loop;
end establish_label_list;

procedure parse_control is
  line       : str120;
  count      : natural;
  line_count : integer := 0;
  debug      : boolean := false;
  found      : boolean;
  caller     : call_node_ptr;

  function control_opcode(opcode : str6) return boolean is
    debug : boolean := false;
  begin
    if debug then put(opcode); end if;
```

```
      if opcode = "BCC    " or
         opcode = "BCS    " or
         opcode = "BEQ    " or
         opcode = "BGE    " or
         opcode = "BGT    " or
         opcode = "BHI    " or
         opcode = "BLE    " or
         opcode = "BLS    " or
         opcode = "BLT    " or
         opcode = "BMI    " or
         opcode = "BNE    " or
         opcode = "BPL    " or
         opcode = "BRA    " or
         opcode = "BSR    " or
         opcode = "BVC    " or
         opcode = "BVS    " or
         opcode = "JMP    " or
         opcode = "JSR    " then
        if debug then put_line(" - TRUE"); end if;
        if debug then skip_line; end if;
        return true;
      else
        if debug then put_line(" - FALSE"); end if;
        if debug then skip_line; end if;
        return false;
      end if;
    end control_opcode;

  begin
    while not end_of_file(input_file) loop
      get_line(input_file, line, count);
      for i in count + 1 .. line'last loop
        line(i) := ' ';
      end loop;

      line_count := line_count + 1;
      if debug then put_line(line(1..count)); end if;
      -- CHECK IF THE LINE ISN'T A COMMENT
      if line(1) /= '*' then
        -- NOT A COMMENT

        opcode  := line(opcode_range);
        operand  := line(operand_range);

        if control_opcode(opcode) then
          if debug then put_line("FOUND BRANCH OPCODE - LOOKING FOR " &
operand); end if;
          -- SEARCH THE LABEL LIST FOR THE OPERAND
          search := label_list;
          found := false;
          while not found loop
            --if debug then put_line("COMPARING " & operand & " TO " &
search.label); end if;
            if operand = search.label then
              -- FOUND MATCH, ADD CURRENT LINE NUMBER TO LIST
              if debug then put_line("FOUND MATCHING LABEL - ADDING
LINE NUMBER"); end if;
```

```
              -- ADD TO END
              new_caller       := new call_node;
              new_caller.next  := null;
              new_caller.caller:= line_count;
              if search.called_by = null then
                search.called_by := new_caller;
              else
                caller := search.called_by;
                while caller.next /= null loop
                  caller := caller.next;
                end loop;
                caller.next := new_caller;
              end if;
              found := true;
            else
              search := search.next;
              if search = null then
                put_line("COULD NOT FIND LABEL " & operand & " AT LINE
" & integer'image(line_count));
                found := true;
              end if;
            end if;
          end loop;
        end if;
      end if;
      if debug then skip_line; end if;
    end loop;
  end parse_control;

  procedure report_results is
  begin
    while label_list /= null loop
      put(label_list.label & " (");
      if label_list.line < 10 then
        put(label_list.line, 1);
      elsif label_list.line < 100 then
        put(label_list.line, 2);
      elsif label_list.line < 1000 then
        put(label_list.line, 3);
      else
        put(label_list.line, 4);
      end if;
      put(") ");
      while label_list.called_by /= null loop
        put(" ");
        put(label_list.called_by.caller, 4);
        label_list.called_by := label_list.called_by.next;
      end loop;
      label_list := label_list.next;
      new_line;
    end loop;
  end report_results;

begin
  open(input_file, in_file, "s_dbp.src");
  create(output_file, out_file, "s_dbp.lst");
  establish_label_list;
```

```
  close(input_file);
  close(output_file);
  open(input_file, in_file, "s_dbp.src");
  parse_control;
  close(input_file);
  report_results;
end parser;
```

APPENDIX D

A. DATA BUFFER PROCESSOR SOURCE CODE LISTING

```
 1 ************************************************************
 2 *
 3 *       BEGIN POWER ON INIT
 4 *
 5         ORG     0DC00H
 6 PWRON   LDS     #00FFFH
 7         SEI
 8         LDX     #IRS
 9         STX     0FFF8H
10         STAA    MPUB
11         JSR     INIT
12         STAA    BRATE1    SET BIT RATES = 75 BPS
13         STAA    BRATE2
14         LDAA    #055H      **TEST RAM**
15         CLRB
16 RAMT    LDX     #0FFCH
17 RAMTST  STAA    0,X
18         CMPA    0,X
19         BNE     RAMERR
20         STAA    MPUB
21         DEX
22         BNE     RAMTST
23         TSTB
24         BNE     TSTROM
25         LDAA    #0AAH      TEST OTHER RAM BITS
26         INCB
27         BRA     RAMT
28 TSTROM  JSR     ROMTST    **NOP FOR TESTING**
29         JSR     CLEAR
30         BRA     PWRON1
31 RAMERR  LDAA    #020H      **RAM ERROR**
32         STAA    LATCH2    *****
33         STAA    MPUB      CRASH
34         BRA     RAMERR    *****
35 ************************************************************
36 *
37 *
38 ROMTST  CLRA              **TEST ROM**
39         CLRB
40         LDX     #PWRON
41 ROMTSA  ADDA    0,X
42         ADCB    #0
43         STAA    MPUB
44         INX
45         CPX     #PGMTOP
46         BNE     ROMTSA
47         CMPA    CKSMA
48         BNE     ROMERR
49         CMPB    CKSMB
```

```
 50         BNE     ROMERR
 51         RTS
 52 *
 53 ROMERR   LDAA    #040H      **ROM ERROR**
 54         STAA    LATCH2     *****
 55         STAA    MPUB       CRASH
 56         BRA     ROMERR     *****
 57 *
 58 PWRON1   JSR     SETUP1
 59         LDAA    PIA1AD     CLEAR LATCHED INPUTS
 60         LDAA    PIA1BD
 61         LDAA    #09DH      ENABLE INTERRUPTS ON ACIA
 62         STAA    ACIACS
 63         CLI
 64         JMP     TDMA
 65 ************************************************************
 66 *
 67 *
 68 INIT     LDAA    #01FH      MASTER RESET ACIA
 69         STAA    ACIACS     DISABLE INTERRUPTS
 70         LDAA    #0FH
 71         STAA    LATCH3     RESET I/O FIFOS
 72         CLRA               I/O PORT & PIA INIT
 73         STAA    PIA1AC
 74         STAA    PIA1BC
 75         STAA    IO1+1
 76         STAA    IO1+3
 77         STAA    IO2+1
 78         STAA    IO2+3
 79         STAA    IO3+1
 80         STAA    IO3+3
 81         STAA    IO4+1
 82         STAA    IO4+3
 83         STAA    IO1        SET DATA DIRECTION REG
 84         STAA    IO2        A - SIDE = INPUTS
 85         STAA    IO3        FOR I/O PORT
 86         STAA    IO4
 87         COMA
 88         STAA    PIA1AD
 89         STAA    PIA1BD
 90         STAA    IO1+2      B-SIDE = OUTPUTS
 91         STAA    IO2+2      FOR I/O PORT
 92         STAA    IO3+2
 93         STAA    IO4+2
 94         LDAA    #03EH      SET CONTROL REG
 95         STAA    PIA1AC
 96         LDAA    #02EH
 97         STAA    IO1+1
 98         STAA    IO1+3
 99         STAA    IO2+1
100         STAA    IO2+3
101         STAA    IO3+1
102         STAA    IO3+3
103         STAA    IO4+1
104         STAA    IO4+3
105         STAA    PIA1BC
106         LDAA    PIA1AD     CLEAR LATCHED INPUTS
```

```
107         LDAA    PIA1BD
108         CLRA
109         STAA    PIA1AD
110         STAA    LATCH1    CLEAR SIGNAL ACQ. LINES
111         STAA    LATCH2
112         RTS
113 ************************************************************
114 *
115 *
116 CLEAR   CLRA              CLEAR RAM MEMORY
117         LDX     #0FF8H
118 CLEARA  STAA    0,X
119         DEX
120         BNE     CLEARA
121         STAA    INPT1
122         RTS
123 ************************************************************
124 *
125 *
126 SETUP   BSR     CLEAR
127 SETUP1  INCA
128         STAA    TDMAFG    SETUP RCCOW & CCOW PORTS
129         INCA
130         STAA    MSDO1
131         STAA    MSDO2
132         STAA    MSDO3
133         STAA    MSDO4
134         LDAA    #0FH       INIT FIFO MR INFO
135         STAA    MRFTA
136         STAA    LATCH3
137         LDX     #ERCRX
138         STX     RCRXPT
139         LDAA    DATA1     CHECK FOR 'TEST 1' MODE
140         BITA    #010H
141         BEQ     SETUP3
142         LDAA    #0FH
143         STAA    PTONRX
144         LDAA    #024H
145         STAA    BRATE1    INIT BIT RATES
146         STAA    BRATE2    FOR TEST #1 MODE:
147         LDAA    #020H      ALL = 2400 BPS
148         STAA    CHRAT1
149         STAA    CHRAT2
150         STAA    CHRAT3
151         STAA    CHRAT4
152 SETUP3  RTS
153 ************************************************************
154 *
155 *
156 TDMA    STAA    MPUB      ***BITE OUTPUT***
157         LDAA    DATA1     CHECK TDMA SWITCH FLAG
158         BITA    #020H      OF T&C PROCESSOR
159         BNE     TDMA1
160         LDAB    TDMAFG
161         BNE     TDMAI
162 ************************************************************
163 *
```

```
164 *NON-TDMA SERVICE
165 *
166         BITA    #01H       CHECK NON-TDMA TX REQ
167         BEQ     TDMAA
168         LDAA    #01FH      SET TX ACK
169         BRA     TDMAB
170 TDMAA   LDAA    #0FH       CLEAR TX ACK
171 TDMAB   STAA    LATCH3
172         BRA     TDMA
173 *
174 TDMAI   SEI
175         JSR     INIT       INIT. FOR NON-TDMA
176         CLR     TDMAFG
177         CLR     PIA1BD
178         LDAA    DATA3      RESET TX FIFO
179         LDAA    #036H
180         STAA    PIA1AC     STROBE "NON-TDMA START"
181         LDAA    #03EH
182         STAA    PIA1AC
183         BRA     TDMA
184 *
185 TDMA1   LDAA    TDMAFG
186         BNE     RBI
187         STAA    PTONRX     TURN ALL PORTS OFF
188         BSR     SETUP1     INIT FOR TDMA
189         LDAA    #09DH       ENABLE RX INTERRUPTS
190         STAA    ACIACS
191         CLI
192 ************************************************************
193 *
194 *
195 RBI     LDAA    PIA1AC     CHECK RCV SETUP RDY
196         BMI     RBIA
197         JMP     TBI
198 RBIA    LDAB    SIEN
199         BEQ     RBIB
200         LDAB    BITELT     SYST INPUT FIFO BITE
201         ORAB    #020H       (RX FIFO)
202         STAB    BITELT
203         CLR     SIEN       CLEAR INPUT FIFO FLAGS
204         CLR     SELFTR
205         CLR     FILLFG
206         CLR     INPTRC
207 *
208 *****  BEGIN RECEIVE BURST INIT  *****
209 *
210 RBIB    LDAB    PIA1AD     CLR LATCHED STROBE
211         LDAA    DATA4      LOAD RCV SETUP DATA
212         LDAB    SELFTR
213         BEQ     RBIBA
214         LDAB    BITELT     *SELF TEST FAIL BITE*
215         ORAB    #080H
216         STAB    BITELT
217 RBIBA   ANDA    #0C7H
218         TAB
219         ANDA    #7
220         CLR     MASKIO
```

```
221         CMPA    #1
222         BEQ     RBI1C
223         JMP     RBI2B
224 *
225 RBI1C   LDAA    XMTRQ1    **PORT #1 RX BURST INIT**
226         BEQ     RBI1CA
227         JMP     TBI
228 RBI1CA  LDAA    PTONRX
229         ANDA    #1
230         BNE     RBI1D
231         JMP     TBI
232 RBI1D   ORAB    CHRAT1
233         LDAA    UT1
234         BEQ     RBI1E
235         LDAA    DATA6     CHECK FIFO'S "O.R."
236         BITA    #8
237         BNE     RBI1DA
238         LDAA    BITELT    ***I/O FIFO #1 BITE***
239         ORAA    #2
240         STAA    BITELT
241 RBI1DA  CLR     UT1
242 RBI1E   LDAA    #1
243         STAA    MASKIO    INIT I/O ON/OFF MASK
244         TSTB
245         BMI     RBI1G
246         LDAA    MSDO1
247         BEQ     RBI1EA
248         CLR     FLBFG1    TWO OR MORE MISSING DO'S
249         LDAA    #2
250         STAA    MSDO1
251         JMP     TBI
252 RBI1EA  INCA              **FIRST MISSING DO SETUP**
253         STAA    FMSDO1
254         STAA    MSDO1
255         STAA    FILLFG    SETUP TO STUFF
256         LDAA    CHCT1     "FF" INTO BUFFER
257         LDAB    CHCT1+1
258         ADDB    #32       ADJ COUNT FOR I/O FIFO
259         ADCA    #0
260         STAA    MDOCT1
261         STAB    MDOCT1+1
262         LDAB    CHRAT1
263         BRA     RBI1H1
264 RBI1G   LDAA    MSDO1
265         CMPA    #2        TWO OR MORE MISSING DO'S?
266         BNE     RBI1H
267         LDAA    MRFTA
268         ORAA    #1        RESET I/O #1 FIFO
269         STAA    MRFTA
270         STAA    LATCH3
271 RBI1GA  LDX     #SBUFF1    INIT BUFFER #1 AND
272         STX     OUTPT1    I/O FIFO #1
273         STAA    FLBFG1
274         CLRA
275         STAA    CHCT1
276         LDAA    #0FFH      **RX ELAST BUFF CH**
277         TST     BPS16K    16KBPS?
```

```
278         BEQ     RBI1GB
279         JSR     STUFF     16 KBPS ELASTIC BUF. CHARS.
280         STX     INPT1
281         LDX     #256      17 MIN. ELASTIC BUFF
282         STX     CHCT1
283         BRA     RBI1H
284 RBI1GB  STAA    SBUFF1    RCV BURST
285         STAA    SBUFF1+1
286         STAA    SBUFF1+2
287         STAA    SBUFF1+3
288         STAA    SBUFF1+4
289         LDAA    #5
290         STAA    CHCT1+1
291         LDX     #SBUFF1+5
292         STX     INPT1
293 RBI1H   CLR     MSDO1
294 RBI1H1  LDX     #INPT1    INIT FOR INPUT
295         STX     RXPNTR    FIFO SERVICE
296         LDAA    BPS16K
297         BEQ     RBI1HA    16 KBPS?
298         LDX     #EBUFF4
299         STX     RXUVAL    INIT 16 KBPS BUFFER PNTRS.
300         LDX     #SBUFF1
301         STX     RXLVAL
302         BRA     RBI1HB
303 RBI1HA  LDX     #EBUFF1
304         STX     RXUVAL
305         LDX     #SBUFF1
306         STX     RXLVAL
307 RBI1HB  LDAA    SIGACQ    SET "SIGNAL ACQ. I/O #1"
308         ORAA    #1
309         STAA    SIGACQ
310         STAA    LATCH1
311         JMP     RBIS
312 *
313 RBI2B   CMPA    #2
314         BEQ     RBI2C
315         JMP     RBI3B
316 RBI2C   LDAA    XMTRQ2    **PORT #2 BURST INIT**
317         BEQ     RBI2CA
318         JMP     TBI
319 RBI2CA  LDAA    PTONRX
320         ANDA    #2
321         BNE     RBI2D
322         JMP     TBI
323 RBI2D   ORAB    CHRAT2
324         LDAA    UT2
325         BEQ     RBI2E
326         LDAA    DATA6     CHECK FIFO'S "O.R."
327         BITA    #4
328         BNE     RBI2DA
329         LDAA    BITELT    ***I/O FIFO #2 BITE***
330         ORAA    #4
331         STAA    BITELT
332 RBI2DA  CLR     UT2
333 RBI2E   LDAA    #2
334         STAA    MASKIO    INIT I/O ON/OFF MASK
```

```
335         TSTB
336         BMI     RBI2G
337         LDAA    MSDO2
338         BEQ     RBI2EA
339         CLR     FLBFG2    TWO OR MORE MISSING DO'S
340         LDAA    #2
341         STAA    MSDO2
342         JMP     TBI
343 RBI2EA  INCA              **FIRST MISSING DO SETUP**
344         STAA    FMSDO2
345         STAA    MSDO2
346         STAA    FILLFG    SETUP TO STUFF
347         LDAA    CHCT2     "FF" INTO BUFFER
348         LDAB    CHCT2+1
349         ADDB    #32       ADJ COUNT FOR I/O FIFO
350         ADCA    #0
351         STAA    MDOCT2
352         STAB    MDOCT2+1
353         LDAB    CHRAT2
354         BRA     RBI2H1
355 RBI2G   LDAA    MSDO2
356         CMPA    #2        TWO OR MORE MISSING DO'S?
357         BNE     RBI2H
358         LDAA    MRFTA
359         ORAA    #2        RESET I/O #2 FIFO
360         STAA    MRFTA
361         STAA    LATCH3
362 RBI2GA  LDX     #SBUFF2    INIT BUFFER #2 AND
363         STX     OUTPT2    I/O FIFO #2
364         STAA    FLBFG2
365         CLRA
366         STAA    CHCT2
367         LDAA    #0FFH      **RX ELAST BUFF CH**
368         TST     BPS16K    16KBPS?
369         BEQ     RBI2GB
370         JSR     STUFF     16KBPS ELASTIC BUF. CHARS.
371         STX     INPT2
372         LDX     #256      17 MIN ELAST BUFF
373         STX     CHCT2
374         LDX     #SBUFF1
375         STX     OUTPT2
376         BRA     RBI2H
377 RBI2GB  STAA    SBUFF2    RCV BURST
378         STAA    SBUFF2+1
379         STAA    SBUFF2+2
380         STAA    SBUFF2+3
381         STAA    SBUFF2+4
382         LDAA    #5
383         STAA    CHCT2+1
384         LDX     #SBUFF2+5
385         STX     INPT2
386 RBI2H   CLR     MSDO2
387 RBI2H1  LDX     #INPT2    INIT FOR INPUT
388         STX     RXPNTR    FIFO SERVICE
389         LDAA    BPS16K
390         BEQ     RBI2HA    16 KBPS?
391         LDX     #EBUFF4
```

```
392         STX     RXUVAL    INIT. 16KBPS BUF. PNTRS.
393         LDX     #SBUFF1
394         STX     RXLVAL
395         BRA     RBI2HB
396 RBI2HA  LDX     #EBUFF2
397         STX     RXUVAL
398         LDX     #SBUFF2
399         STX     RXLVAL
400 RBI2HB  LDAA    SIGACQ    SET "SIGNAL ACQ. I/O #2"
401         ORAA    #2
402         STAA    SIGACQ
403         STAA    LATCH1
404         JMP     RBIS
405 *
406 RBI3B   CMPA    #3
407         BEQ     RBI3C
408         JMP     RBI4B
409 RBI3C   LDAA    XMTRQ3    **PORT #3 BURST INIT**
410         BEQ     RBI3CA
411         JMP     TBI
412 RBI3CA  LDAA    PTONRX
413         ANDA    #4
414         BNE     RBI3D
415         JMP     TBI
416 RBI3D   ORAB    CHRAT3
417         LDAA    UT3
418         BEQ     RBI3E
419         LDAA    DATA6     CHECK FIFO'S "O.R."
420         BITA    #2
421         BNE     RBI3DA
422         LDAA    BITELT    **I/O FIFO #3 BITE***
423         ORAA    #8
424         STAA    BITELT
425 RBI3DA  CLR     UT3
426 RBI3E   LDAA    #4
427         STAA    MASKIO    INIT I/O ON/OFF MASK
428         TSTB
429         BMI     RBI3G
430         LDAA    MSDO3
431         BEQ     RBI3EA
432         CLR     FLBFG3
433         LDAA    #2
434         STAA    MSDO3
435         JMP     TBI
436 RBI3EA  INCA              **FIRST MISSING DO SETUP**
437         STAA    FMSDO3
438         STAA    MSDO3
439         STAA    FILLFG    SETUP TO STUFF
440         LDAA    CHCT3     "FF" INTO BUFFER
441         LDAB    CHCT3+1
442         ADDB    #32       ADJ COUNT FOR I/O FIFO
443         ADCA    #0
444         STAA    MDOCT3
445         STAB    MDOCT3+1
446         LDAB    CHRAT3
447         BRA     RBI3H1
448 RBI3G   LDAA    MSDO3
```

```
449         CMPA   #2        TWO OR MORE MISSING DO'S?
450         BNE    RBI3H
451         LDAA   MRFTA
452         ORAA   #4        RESET I/O FIFO #3
453         STAA   MRFTA
454         STAA   LATCH3
455 RBI3GA  LDX    #SBUFF3    INIT BUFFER #3 AND
456         STX    OUTPT3    I/O FIFO #3
457         STAA   FLBFG3
458         CLRA
459         STAA   CHCT3
460         LDAA   #0FFH      **RX ELAST BUFF CH**
461         TST    BPS16K    16KBPS?
462         BEQ    RBI3GB
463         JSR    STUFF     16 KBPS ELASTIC BUF. CHARS.
464         STX    INPT3
465         LDX    #256      17 MIN ELASTIC BUFF
466         STX    CHCT3
467         LDX    #SBUFF1
468         STX    OUTPT3
469         BRA    RBI3H
470 RBI3GB  STAA   SBUFF3    RCV BURST
471         STAA   SBUFF3+1
472         STAA   SBUFF3+2
473         STAA   SBUFF3+3
474         STAA   SBUFF3+4
475         LDAA   #5
476         STAA   CHCT3+1
477         LDX    #SBUFF3+5
478         STX    INPT3
479 RBI3H   CLR    MSDO3
480 RBI3H1  LDX    #INPT3    INIT FOR INPUT
481         STX    RXPNTR    FIFO SERVICE
482         LDAA   BPS16K
483         BEQ    RBI3HA
484         LDX    #EBUFF4
485         STX    RXUVAL    INIT 16KBPS PNTRS
486         LDX    #SBUFF1
487         STX    RXLVAL
488         BRA    RBI3HB
489 RBI3HA  LDX    #EBUFF3
490         STX    RXUVAL
491         LDX    #SBUFF3
492         STX    RXLVAL
493 RBI3HB  LDAA   SIGACQ    SET "SIGNAL ACQ. I/O #3"
494         ORAA   #4
495         STAA   SIGACQ
496         STAA   LATCH1
497         JMP    RBIS
498 *
499 RBI4B   CMPA   #4
500         BEQ    RBI4C
501         JMP    RBIJ
502 RBI4C   LDAA   XMTRQ4    **PORT #4 BURST INIT**
503         BEQ    RBI4CA
504         JMP    TBI
505 RBI4CA  LDAA   PTONRX
```

```
506         ANDA    #8
507         BNE     RBI4D
508         JMP     TBI
509 RBI4D   ORAB    CHRAT4
510         LDAA    UT4
511         BEQ     RBI4E
512         LDAA    DATA6     CHECK FIFO'S "O.R."
513         BITA    #1
514         BNE     RBI4DA
515         LDAA    BITELT    **I/O FIFO #4 BITE***
516         ORAA    #010H
517         STAA    BITELT
518 RBI4DA  CLR     UT4
519 RBI4E   LDAA    #8
520         STAA    MASKIO    INIT I/O ON/OFF MASK
521         TSTB
522         BMI     RBI4G
523         LDAA    MSDO4
524         BEQ     RBI4EA
525         CLR     FLBFG4    TWO OR MORE MISSING DO'S
526         LDAA    #2
527         STAA    MSDO4
528         JMP     TBI
529 RBI4EA  INCA              **FIRST MISSING DO SETUP**
530         STAA    FMSDO4
531         STAA    MSDO4
532         STAA    FILLFG    SETUP TO STUFF
533         LDAA    CHCT4     "FF" INTO BUFFER
534         LDAB    CHCT4+1
535         ADDB    #32       ADJ COUNT FOR I/O FIFO
536         ADCA    #0
537         STAA    MDOCT4
538         STAB    MDOCT4+1
539         LDAB    CHRAT4
540         BRA     RBI4H1
541 RBI4G   LDAA    MSDO4
542         CMPA    #2        TWO OR MORE MISSING DO'S?
543         BNE     RBI4H
544         LDAA    MRFTA
545         ORAA    #08H       RESET I/O FIFO #4
546         STAA    MRFTA
547         STAA    LATCH3
548 RBI4GA  LDX     #SBUFF4    INIT BUFFER #4 AND
549         STX     OUTPT4    I/O FIFO #4
550         STAA    FLBFG4
551         CLRA
552         STAA    CHCT4
553         LDAA    #0FFH      **RX ELAST BUFF CH**
554         TST     BPS16K    16KBPS?
555         BEQ     RBI4GB
556         JSR     STUFF     16 KBPS ELASTIC BUFF. CHARS
557         STX     INPT4
558         LDX     #256      17 MIN ELASTIC BUFF
559         STX     CHCT4
560         LDX     #SBUFF1
561         STX     OUTPT4
562         BRA     RBI4H
```

```
563 RBI4GB STAA   SBUFF4   RCV BURST
564        STAA   SBUFF4+1
565        STAA   SBUFF4+2
566        STAA   SBUFF4+3
567        STAA   SBUFF4+4
568        LDAA   #5
569        STAA   CHCT4+1
570        LDX    #SBUFF4+5
571        STX    INPT4
572 RBI4H  CLR    MSDO4
573 RBI4H1 LDX    #INPT4    INIT FOR INPUT
574        STX    RXPNTR    FIFO SERVICE
575        LDAA   BPS16K
576        BEQ    RBI4HA
577        LDX    #EBUFF4
578        STX    RXUVAL    INIT 16KBPS PNTRS
579        LDX    #SBUFF1
580        STX    RXLVAL
581        BRA    RBI4HB
582 RBI4HA LDX    #EBUFF4
583        STX    RXUVAL
584        LDX    #SBUFF4
585        STX    RXLVAL
586 RBI4HB LDAA   SIGACQ    SET "SIGNAL ACQ I/O #4"
587        ORAA   #8
588        STAA   SIGACQ
589        STAA   LATCH1
590        JMP    RBIS
591 ************************************************************
592 *
593 *
594 RBIJ   CMPA   #7        CHECK FOR SELF TEST RX BURS
595        BNE    RBIJA
596        STAA   SELFTR
597        LDAA   #0        INIT. RX FIFO COUNT
598        LDAB   #60
599        JMP    RBIT
600 RBIJA  LDX    RCRXPT
601        CPX    #ERCRX    R/CCOW RX BUFFER EMPTY?
602        BEQ    RBIK
603        PSHA             **RCCOW/CCOW ERROR**
604        LDAA   BITELT
605        ORAA   #1
606        STAA   BITELT
607        PULA
608        LDX    #ERCRX
609        STX    RCRXPT
610 RBIK   LDX    #SRCRX
611        CMPA   #6
612        BNE    RBIN
613        TSTB             CCOW DO?
614        BMI    RBIL
615        LDAA   #0A5H      OUTPUT CCOW DO
616 RBIKA  STAA   ACIAD     ABSENT CODE TO SCU
617        JMP    TBI
618 *
619 RBIL   LDAA   DATA1     TX REQUEST STATUS                  WBR
```

```
620         ANDA    #0FH                                                WBR
621         ORAA    #0C0H                                               WBR
622         STAA    ACIAD       SEND C CODE TO SCP                      WBR
623 *
624         LDAA    #0A1H        CCOW DO PRESENT CODE
625 RBIM    STAA    0,X
626         INX                 ADJ R/CCOW RX BUFFER PNTR
627         STX     RCRXPT
628         STAA    INPTRC
629         STAA    SIEN
630         JMP     TBI
631 RBIN    TSTB                RCCOW DO?
632         BMI     RBIO
633         LDAA    #0A6H        RCCOW DO ABSENT CODE
634         BRA     RBIKA
635 RBIO    LDAA    #0A2H        RCCOW DO PRESENT CODE
636         BRA     RBIM
637 RBIS    BSR     BITRAT
638         BRA     RBIT
639 ************************************************************
640 *
641 *
642 BITRAT  TST     BPS16K      TEST 16KBPS
643         BNE     RBISF
644         ASLB
645         BMI     RBIU
646         ANDB    #070H
647         BNE     RBISA
648         LDAB    #13         75 BPS @ 1.386 SEC
649         CLRA                13 BYTES
650         RTS
651 RBISA   CMPB    #010H
652         BNE     RBISB
653         LDAB    #52         300 BPS @ 1.386 SEC
654         CLRA                52 BYTES
655         RTS
656 RBISB   CMPB    #020H
657         BNE     RBISC
658         LDAB    #104        600 BPS @ 1.386 SEC
659         CLRA                104 BYTES
660         RTS
661 RBISC   CMPB    #030H
662         BNE     RBISD
663         LDAB    #208        1200 BPS @ 1.386 SEC
664         CLRA                208 BYTES
665         RTS
666 RBISD   CMPB    #040H
667         BNE     RBISE
668         LDAB    #0A0H        2400 BPS @ 1.386 SEC
669         LDAA    #1          416 BYTES
670         RTS
671 RBISE   LDAB    #040H        4800 BPS @ 1.386 SEC
672         LDAA    #3          832 BYTES
673         RTS
674 RBISF   LDAB    #0D5H        16000 BPS @ 1.386 SEC
675         LDAA    #0AH         2773 BYTES
676         RTS
```

```
677 RBIU   LDAB   #78       75 BPS @ 8.32 SEC
678        CLRA             78 BYTES
679        RTS
680 ************************************************************
681 *
682 *
683 RBIT   STAA   INCHC     MSB'S OF CH. CNT.
684        STAB   INCHC+1    LSB'S OF CH. CNT.
685        CLRA
686        STAA   INPTRC
687        INCA
688        STAA   SIEN
689 ************************************************************
690 *
691 *
692 TBI    LDAA   CDRDY     TEST CCOW DATA RDY FLG.
693        BEQ    TBI1
694        CLR    CDRDY
695        LDAA   PA1AD
696        ORAA   #020H      SET DATA RDY CCOW*
697        BRA    TBI2
698 TBI1   LDAA   RDRDY     TEST RCCOW RDY FLG.
699        BEQ    TBI3
700        CLR    RDRDY
701        LDAA   PA1AD
702        ORAA   #010H      SET DATA RDY RCCOW*
703 TBI2   STAA   PA1AD
704        STAA   PIA1AD
705 TBI3   LDAA   IRSBIT    IRS BITE?
706        BEQ    TBI4
707        LDAA   BITELT
708        ORAA   #01H
709        STAA   BITELT
710 TBI4   LDAA   PIA1BC    CHECK TX SETUP READY
711        BMI    TBIA
712        JMP    IO1PT
713 TBIA   LDAA   SOEN
714        BEQ    TBIB
715        LDAB   BITELT    SYST OUTPUT FIFO BITE
716        ORAB   #040H      (TX FIFO)
717        STAB   BITELT
718 *
719 ***** BEGIN TRANSMIT BURST INITIALIZATION *****
720 *
721 TBIB   LDAA   PIA1BD    CLR LATCHED STROBE
722        LDAA   DATA3     LOAD TX SETUP DATA
723        LDAB   DATA5     CHECK TX INHIBIT
724        BITB   #1
725        BEQ    TIBA
726        ANDA   #7
727        CMPA   #7
728        BEQ    TBIBA
729        JMP    IO1PT     TX INHIBIT: ABORT
730 TBIBA  JMP    TBIG      ALLOW SELF TEST BURST
731 TIBA   ANDA   #047H
732        TAB
733        ANDA   #7
```

```
734         CMPA    #1
735         BNE     TBI2B
736         LDAA    PTONRX      IS PORT ON?
737         BITA    #1
738         BNE     TBI1BA
739         JMP     IO1PT       ABORT:  PORT IS OFF
740 *
741 TBI1BA  TST     BPS16K
742         BEQ     TBI1E
743         LDX     #SBUFF1     16 KBPS
744         STX     TXLVAL
745         LDX     #EBUFF4
746         STX     TXUVAL
747         BRA     TBI1EA
748 TBI1E   LDX     #SBUFF1     INIT FOR OUTPUT
749         STX     TXLVAL    FIFO SERVICE
750         LDX     #EBUFF1
751         STX     TXUVAL
752 TBI1EA  LDX     #INPT1
753         STX     TXPNTR
754         CLRA
755         STAA    UT1
756         STAA    MDOCT1
757         STAA    MDOCT1+1
758         STAA    FMSDO1
759         LDAA    #2
760         STAA    MSDO1
761         LDAA    #0FEH
762         STAA    XMASK
763         LDAA    #0EFH
764         STAA    MASKR
765         LDAA    GROUP1
766         BEQ     TBI1F
767         STAA    GRP1FG
768 TBI1F   CLRA
769         STAA    GROUP1
770         ORAB    CHRAT1
771         JMP     TBIN
772 *
773 TBI2B   CMPA    #2
774         BNE     TBI3B
775         LDAA    PTONRX      IS PORT ON?
776         BITA    #2
777         BNE     TBI2BA
778         JMP     IO1PT       ABORT:  PORT IS OFF
779 TBI2BA  TST     BPS16K
780         BEQ     TBI2E
781         LDX     #SBUFF1     16 KBPS
782         STX     TXLVAL
783         LDX     #EBUFF4
784         STX     TXUVAL
785         BRA     TBI2EA
786 TBI2E   LDX     #SBUFF2     INIT. FOR OUTPUT
787         STX     TXLVAL    FIFO SERVICE
788         LDX     #EBUFF2
789         STX     TXUVAL
790 TBI2EA  LDX     #INPT2
```

```
791         STX     TXPNTR
792         CLRA
793         STAA    UT2
794         STAA    MDOCT2
795         STAA    MDOCT2+1
796         STAA    FMSDO2
797         LDAA    #2
798         STAA    MSDO2
799         LDAA    #0FDH
800         STAA    XMASK
801         LDAA    #0DFH
802         STAA    MASKR
803         LDAA    GROUP2
804         BEQ     TBI2F
805         STAA    GRP1FG
806 TBI2F   CLRA
807         STAA    GROUP2
808         ORAB    CHRAT2
809         JMP     TBIN
810 *
811 TBI3B   CMPA    #3
812         BNE     TBI4B
813         LDAA    PTONRX      IS PORT ON?
814         BITA    #4
815         BNE     TBI3BA
816         JMP     IO1PT       ABORT:  PORT IS OFF
817 TBI3BA  TST     BPS16K
818         BEQ     TBI3E
819         LDX     #SBUFF1     16 KBPS
820         STX     TXLVAL
821         LDX     #EBUFF4
822         STX     TXUVAL
823         BRA     TBI3EA
824 TBI3E   LDX     #SBUFF3     INIT. FOR OUPTUT
825         STX     TXLVAL     FIFO SERVICE
826         LDX     #EBUFF3
827         STX     TXUVAL
828 TBI3EA  LDX     #INPT3
829         STX     TXPNTR
830         CLRA
831         STAA    UT3
832         STAA    MDOCT3
833         STAA    MDOCT3+1
834         STAA    FMSDO3
835         LDAA    #2
836         STAA    MSDO3
837         LDAA    #0FBH
838         STAA    XMASK
839         LDAA    #0BFH
840         STAA    MASKR
841         LDAA    GROUP3
842         BEQ     TBI3F
843         STAA    GRP1FG
844 TBI3F   CLRA
845         STAA    GROUP3
846         ORAB    CHRAT3
847         JMP     TBIN
```

```
848 *
849 TBI4B  CMPA   #4
850        BNE    TBIG
851        LDAA   PTONRX    IS PORT ON?
852        BITA   #8
853        BNE    TBI4BA
854        JMP    IO1PT     ABORT:  PORT IS OFF
855 TBI4BA TST    BPS16K
856        BEQ    TBI4E
857        LDX    #SBUFF1   16 KBPS
858        STX    TXLVAL
859        LDX    #EBUFF4
860        STX    TXUVAL
861        BRA    TBI4EA
862 TBI4E  LDX    #SBUFF4   INIT. FOR OUTPUT
863        STX    TXLVAL   FIFO SERVICE
864        LDX    #EBUFF4
865        STX    TXUVAL
866 TBI4EA LDX    #INPT4
867        STX    TXPNTR
868        CLRA
869        STAA   UT4
870        STAA   MDOCT4
871        STAA   MDOCT4+1
872        STAA   FMSDO4
873        LDAA   #2
874        STAA   MSDO4
875        LDAA   #0F7H
876        STAA   XMASK
877        LDAA   #07FH
878        STAA   MASKR
879        LDAA   GROUP4
880        BEQ    TBI4F
881        STAA   GRP1FG
882 TBI4F  CLRA
883        STAA   GROUP4
884        ORAB   CHRAT4
885        JMP    TBIN
886 *
887 TBIG   CMPA   #7       CHECK FOR SELF TEST TX BURS
888        BNE    TBIGA
889        STAA   SOEN
890        STAA   SELFTT
891        LDX    #08000H  DUMMY VALUE FOR TXPNTR
892        STX    TXPNTR
893        LDX    #28      SELF TEST CH CNT - 32
894        STX    OUTCHC
895        LDAA   #32
896        LDAB   #033H     SELF TEST TX CHAR
897 TBIG1  STAB   PIA1BD
898        DECA            OUTPUT 32 SELF TEST
899        BNE    TBIG1    CHARS. TO TX FIFO
900        JMP    RBI
901 TBIGA  CMPA   #6
902        BNE    TBIJ
903        LDAA   PA1AD    IF NO DATA READY, OUTPUT
904        BITA   #020H     13 BYTES OF 11001100
```

```
905         BNE     TBIGC
906         LDAA    #0CCH      **NO CCOW DATA RDY**
907         LDX     #13
908 TBIGB   STAA    PIA1BD
909         DEX
910         BNE     TBIGB
911         BRA     TBIHB
912 TBIGC   LDX     #SCTXB
913         STX     CTXPT
914 TBIH    LDAA    0,X
915         STAA    PIA1BD    PUT CHAR IN OUTPUT FIFO
916         INX
917         CPX     #ECTXB
918         BNE     TBIH
919         LDAA    PA1AD
920         ANDA    #0DFH      CLR DATA READY CCOW
921 TBIHA   STAA    PIA1AD
922         STAA    PA1AD
923 *
924 *
925 TBIHB   ASLB
926         BMI     TBIHC
927         JMP     IO1PT
928 TBIHC   CLRA
929         STAA    PIA1BD
930         STAA    PIA1BD
931         STAA    PIA1BD
932         JMP     IO1PT
933 TBIJ    LDX     #SRTXB
934         STX     RTXPT
935 TBIK    LDAA    0,X
936         STAA    PIA1BD    PUT CHAR IN OUTPUT FIFO
937         INX
938         CPX     #ERTXB
939         BNE     TBIK
940         LDAA    PA1AD
941         ANDA    #0EFH      CLR DATA READY RCCOW
942         BRA     TBIHA
943 TBIN    JSR     BITRAT    GET TX CH. CNT.
944 TBIO    STAA    OUTCHC    MSB'S OF CH. CNT.
945         STAB    OUTCHC+1    LSB'S OF CH. CNT.
946         CLRA
947         INCA
948         STAA    SOEN
949 TBIQ    LDX     TXPNTR
950         LDAA    GRP1FG    CHECK IF FIRST GROUP
951         BEQ     TBIS
952 TBIQ1   LDAA    OUTCHC    ***COMPUTE FILL COUNT***
953         LDAB    OUTCHC+1
954         ADDB    #6        ADD ELASTIC BUFF(48 BITS)
955         ADCA    #0
956         SUBB    5,X       BURST CH CNT + ELASTIC BUFF
957         SBCA    4,X       - BUFF CH CNT = FILL COUNT
958         BCS     TBIR
959         BNE     TBIRA
960         TSTB
961         BNE     TBIRA
```

```
 962 TBIR    CLR     GRP1FG
 963         BRA     TBIS      NO FILL REQUIRED
 964 TBIRA   STAA    FILLCT
 965         STAB    FILLCT+1
 966         LDAA    4,X       NUMBER OF GOOD CHARS IN FIR
 967         LDAB    5,X       BURST=BUFF CH CNT - ELASTIC
 968         SUBB    #6        SUBT ELASTIC BUFF(48 BITS)
 969         SBCA    #0
 970         BCC     TBIRB
 971         CLRA              ERROR: ELASTIC BUFFER NOT
 972         STAA    SOEN      YET FULL FOR TRANSMISSION
 973         LDAA    BITELT
 974         ORAA    #040H      **TX FIFO BITE LITE ON**
 975         STAA    BITELT
 976         BRA     IO1PT
 977 TBIRB   STAA    OUTCHC
 978         STAB    OUTCHC+1
 979 TBIS    JSR     SOFAA     *SERVICE OUTPUT FIFO*
 980 ********************************************************
 981 *
 982 *
 983 *
 984 IO1PT   LDAA    PTONRX    PORT #1 ON?
 985         ANDA    #1
 986         BEQ     IO1A1
 987         CLR     P1OFF
 988         JMP     IO1A
 989 IO1A1   LDAA    P1OFF     PORT IS OFF
 990         BEQ     IO1A2
 991         JMP     IO2PT
 992 IO1A2   STAA    CHCT1
 993         STAA    CHCT1+1
 994         STAA    XMTRQ1
 995         STAA    UT1
 996         LDX     #0
 997         STX     LGDPT1
 998         STAA    OUFG1
 999         STAA    EMPTY1
1000         LDAA    #2
1001         STAA    MSDO1
1002         INCA
1003         STAA    FLBFG1
1004         LDAA    MRFTA
1005         ORAA    #1        RESET FIFO I/O #1
1006         ANDA    #0EFH      CLR "XMT ACK"
1007         STAA    MRFTA
1008         STAA    LATCH3
1009         STAA    P1OFF
1010         LDAA    PA1AD
1011         ANDA    #0FEH      CLEAR "DATA RDY PORT #1"
1012         STAA    PA1AD
1013         STAA    PIA1AD
1014         LDX     #SBUFF1
1015         STX     INPT1
1016         STX     OUTPT1
1017         LDAA    SIGACQ    CLR "SIGNAL ACQ. I/O #1
1018         ANDA    #0FEH
```

```
1019         STAA    SIGACQ
1020         STAA    LATCH1
1021         LDX     TXPNTR
1022         CPX     #INPT1
1023         BNE     IO1A3
1024         CLR     SOEN
1025 IO1A3   JMP     IO2PT
1026 ************************************************************
1027 *
1028 *   INPUT SERVICE SUBROUTINE
1029 *
1030 IO1LS   LDAA    #1
1031         STAA    XFER1
1032         LDAA    IO1       OBTAIN CHAR
1033         LDX     INPT1     GET PUT PNTR
1034         STAA    0,X       PUT IT
1035         INX               INCR PUT PNTR
1036         CPX     OUTPT1    TEST OVERFLOW
1037         BNE     IO1LSX    BRANCH NO OVERFLOW
1038         LDAA    MRFTA     **OVERFLOW**
1039         ANDA    #0EFH      CLR "XMT ACK"
1040         ORAA    #1        RESET FIFO
1041         STAA    MRFTA
1042         STAA    LATCH3
1043         STAA    OUFG1     SET OUFG FLAG
1044         INS               *REMOVE RETURN
1045         INS               *
1046         JMP     IO2PT
1047 IO1LSX  LDAA    BPS16K
1048         BEQ     IO1LSA
1049         CPX     #EBUFF4    16 KBPS
1050         BNE     IO1LSB
1051         LDX     #SBUFF1
1052         BRA     IO1LSB
1053 IO1LSA  CPX     #EBUFF1    TEST END OF INPUT
1054         BNE     IO1LSB    NO
1055         LDX     #SBUFF1    GET INITIAL VALUE
1056 IO1LSB  STX     INPT1
1057         LDX     CHCT1     GET CHAR COUNT
1058         INX               INCR COUNT
1059         STX     CHCT1     PUT BACK
1060         RTS
1061 ************************************************************
1062 *
1063 *LOAD I/O #1 FIFO WITH 1 CHAR. ROUTINE
1064 *
1065 IO1LF   LDX     OUTPT1
1066         LDAA    RXINHB                                    WBR
1067         BITA    #1        IS THE EXTEND TRANSMIT FLAG SET?  WBR
1068         BNE     IO1LF1    YES:RX NOT ALLOWED                WBR
1069         LDAA    0,X
1070         STAA    IO1+2     OUTPUT CH. TO I/O #1 FIFO
1071 IO1LF1  INX
1072         LDAB    BPS16K
1073         BEQ     IO1LFA
1074         CPX     #EBUFF4    16 KBPS
1075         BNE     IO1LFB
```

```
1076         LDX    #SBUFF1
1077         BRA    IO1LFB
1078 IO1LFA CPX    #EBUFF1
1079         BNE    IO1LFB
1080         LDX    #SBUFF1
1081 IO1LFB STX    OUTPT1
1082         LDAA   #1
1083         STAA   XFER1
1084         LDAA   FMSDO1   TEST MISSING DO
1085         BEQ    IO1LFC
1086         LDX    MDOCT1
1087         DEX
1088         STX    MDOCT1
1089         BNE    IO1LFC
1090         LDAA   SIGACQ
1091         ANDA   #0FEH
1092         STAA   SIGACQ
1093         STAA   LATCH1
1094         CLR    FMSDO1
1095 IO1LFC LDX    CHCT1    ADJUST CHAR COUNT
1096         DEX
1097         STX    CHCT1
1098         BNE    IO1LFD
1099         INS             REMOVE RETURN
1100         INS
1101         JMP    IO1YE1   GO CHECK UNDERFLOW
1102 IO1LFD RTS
1103 ************************************************************
1104 *
1105 *LOAD I/O #1 FIFO WITH 3 BUF. CH. ROUTINE
1106 *
1107 LD1    LDX    OUTPT1
1108         LDAA   0,X
1109         STAA   IO1+2
1110         LDAA   1,X
1111         STAA   IO1+2
1112         LDAA   2,X
1113         STAA   IO1+2
1114         INX
1115         INX
1116         INX
1117         STX    OUTPT1
1118         LDX    CHCT1
1119         DEX
1120         DEX
1121         DEX
1122         STX    CHCT1
1123         RTS
1124 ************************************************************
1125 *
1126 *****  BEGIN SERVICING I/O PORT #1   *****
1127 *
1128 IO1A   LDAA   PTONRX   RX ONLY?
1129         BITA   #010H
1130         BEQ    IO1AA
1131         JMP    IO1Y
1132 IO1AA  LDAA   DATA1
```

```
1133         BITA   #1
1134         BNE    IO1B
1135         JMP    IO1Y
1136 IO1B    ASLA
1137         BPL    IO1C
1138         LDAA   XMTRQ1
1139         BNE    IO1C
1140         LDAA   EMPTY1
1141         BNE    IO1CA
1142         LDX    CHCT1     R/T SELECTED: CHECK RCV DON
1143         BEQ    IO1BB
1144 IO1BA   JMP    IO1YD
1145 IO1BB   LDAA   DATA6     TEST: I/O FIFO UNDERFLOW
1146         BITA   #8
1147         BNE    IO1BA     BRANCH: NO UNDERFLOW
1148 IO1C    LDAA   XMTRQ1
1149         BNE    IO1D
1150         LDAA   EMPTY1
1151         BEQ    IO1E
1152 IO1CA   CLR    EMPTY1    GET HERE W/MULTIPLE
1153         STAA   XMTRQ1    TX REQ PER FRAME
1154         LDX    #0
1155         STX    LGDPT1
1156         LDAA   MRFTA
1157         ORAA   #010H      SET "TX ACK"
1158         STAA   MRFTA
1159         STAA   LATCH3
1160 IO1D    LDAA   OUFG1
1161         BEQ    IO1H
1162         STAA   XFER1
1163         JMP    IO2PT
1164 IO1E    LDAA   DATA5     CHECK TX INHIBIT
1165         ANDA   #1
1166         BEQ    IO1F
1167         JMP    IO2PT
1168 IO1F    LDAA   #1        **INIT FOR PORT #1**
1169         STAA   XMTRQ1    **DATA TRANSMISSION**
1170         STAA   GROUP1
1171         STAA   XFER1
1172         STAA   FLBFG1
1173         LDAA   SIGACQ
1174         ORAA   #010H      SELECT I/O INPUT MODE
1175         ANDA   #0FEH      CLR "SIG. ACQ. #1"
1176         STAA   SIGACQ
1177         STAA   LATCH1
1178         LDAA   MRFTA
1179         ORAA   #1        TOGGLE FIFO'S RESET
1180         STAA   LATCH3
1181         CLR    IO1+2     CLR PIA B-SIDE
1182         ANDA   #0FEH
1183         ORAA   #010H      SET "XMT ACK" I/O #1
1184         STAA   MRFTA
1185         STAA   LATCH3
1186         LDX    #SBUFF1+6
1187         STX    INPT1
1188         LDX    #SBUFF1
1189         STX    OUTPT1
```

```
1190          LDAA   #0FFH     STUFF 6 ELASTIC
1191          STAA   0,X       BUFFER CHARACTERS (CC)
1192          STAA   1,X
1193          STAA   2,X
1194          STAA   3,X
1195          STAA   4,X
1196          STAA   5,X
1197          LDX    #6
1198          STX    CHCT1
1199          JMP    IO2PT
1200 IO1G     LDX    #SBUFF1
1201          STX    INPT1
1202          STX    OUTPT1
1203          LDX    #0
1204          STX    CHCT1
1205          LDAA   SIGACQ    CLR "SIGNAL ACQ. I/O #1
1206          ANDA   #0FEH
1207          STAA   SIGACQ
1208          STAA   LATCH1
1209          JMP    IO2PT
1210 IO1H     LDAA   DATA5     CHECK TX INHIBIT
1211          ANDA   #1
1212          BEQ    IO1HA
1213          JMP    IO1YA1
1214 IO1HA    LDAB   FLBFG1
1215          BEQ    IO1HB
1216          JMP    IO1O
1217 IO1HB    LDAA   DATA6     TEST FIFO "O.R."
1218          BITA   #8
1219          BNE    IO1I
1220          JMP    IO1XP
1221 IO1I     JSR    IO1LS     LOAD & STORE 1 CHAR
1222          LDAA   DATA6
1223          BITA   #8
1224          BNE    IO1K
1225          JMP    IO1XP
1226 IO1K     JSR    IO1LS     LOAD & STORE 2 CHAR
1227          LDAA   DATA6
1228          BITA   #8
1229          BNE    IO1M
1230          JMP    IO1XP
1231 IO1M     JSR    IO1LS     LOAD & STORE 3 CHAR
1232          LDAA   DATA6
1233          BITA   #8
1234          BNE    IO1N2
1235          JMP    IO1XP
1236 IO1N2    JSR    IO1LS     LOAD & STORE 4 CHAR
1237          LDAA   BPS16K
1238          BNE    IO1N3
1239          JMP    IO1XP
1240 IO1N3    LDAA   DATA6     *16KBPS:  ALLOW MORE*
1241          BITA   #8        *I/O SERVICING*
1242          BNE    IO1N4
1243          JMP    IO1XP
1244 IO1N4    JSR    IO1LS     LOAD & STORE 5 CHAR.
1245          LDAA   DATA6
1246          BITA   #8
```

```
1247         BNE     IO1N5
1248         JMP     IO1XP
1249 IO1N5   JSR     IO1LS     LOAD & STORE 6 CHAR.
1250         LDAA    DATA6
1251         BITA    #8
1252         BNE     IO1N6
1253         JMP     IO1XP
1254 IO1N6   JSR     IO1LS     LOAD & STORE 7 CHAR.
1255         LDAA    DATA6
1256         BITA    #8
1257         BNE     IO1N7
1258         JMP     IO1XP
1259 IO1N7   JSR     IO1LS     LOAD & STORE 8 CHAR.
1260         LDAA    DATA6
1261         BITA    #8
1262         BNE     IO1N8
1263         JMP     IO1XP
1264 IO1N8   JSR     IO1LS     LOAD & STORE 9 CHAR.
1265         LDAA    DATA6
1266         BITA    #8
1267         BNE     IO1N9
1268         JMP     IO1XP
1269 IO1N9   JSR     IO1LS     LOAD & STORE 10 CHAR.
1270         LDAA    DATA6
1271         BITA    #8
1272         BNE     IO1N10
1273         JMP     IO1XP
1274 IO1N10  JSR     IO1LS     LOAD & STORE 11 CHAR.
1275         JMP     IO1XP
1276 IO1O    LDAA    DATA6
1277         BITA    #8
1278         BEQ     IO1XP
1279 IO1P    CLR     FLBFG1
1280         LDAA    PA1AD     SET "DATA RDY PORT #1"
1281         ORAA    #1
1282         STAA    PA1AD
1283         STAA    PIA1AD
1284         JMP     IO1I
1285 IO1XP   LDAA    EMPTY1    **TEST IF SETUP**
1286         BPL     IO1XQ     **LAST GOOD DATA PNTR**
1287         LDX     INPT1     DO SETUP
1288         STX     LGDPT1
1289         LDAA    #1
1290         STAA    EMPTY1
1291 IO1XQ   JMP     IO2PT
1292 IO1Y    LDAA    XMTRQ1
1293         BEQ     IO1YB
1294         LDAA    MRFTA
1295         ANDA    #0EFH      CLEAR "TX ACK"
1296         STAA    MRFTA
1297         STAA    LATCH3
1298         CLR     XMTRQ1    FIRST TIME THAT
1299         LDAA    #0FFH      TX REQ = FALSE
1300         STAA    EMPTY1
1301         LDAA    PA1AD
1302         ANDA    #1
1303         BNE     IO1YA
```

```
1304          STAA    CHCT1       NO DATA:  ABORT INPUT
1305          STAA    CHCT1+1
1306          STAA    EMPTY1
1307          INCA
1308          STAA    FLBFG1
1309          LDAA    MRFTA
1310          ORAA    #1
1311          STAA    MRFTA
1312          STAA    LATCH3
1313          JMP     IO2PT
1314 IO1YA    JMP     IO1D
1315 IO1YB    LDAA    EMPTY1
1316          BNE     IO1YA
1317          JMP     IO1YD
1318 IO1YA1   CLRA
1319          STAA    XMTRQ1
1320          STAA    EMPTY1
1321          LDAA    PA1AD
1322          ANDA    #0FEH
1323          STAA    PIA1AD    CLEAR "DATA RDY PORT #1"
1324          STAA    PA1AD
1325          LDAA    MRFTA
1326          ORAA    #1        RESET I/O #1 FIFO
1327          ANDA    #0EFH      CLR TX ACK I/O #1
1328          STAA    MRFTA
1329          STAA    LATCH3
1330 IO1YC    LDAA    MRFTA     **INIT I/O PORT **
1331          ORAA    #1        **TO OUTPUT**
1332          STAA    MRFTA     **RX BURST DATA**
1333          STAA    LATCH3    RESET I/O #1 FIFO
1334          LDAA    SIGACQ
1335          ANDA    #0EFH      SELECT I/O OUTPUT MODE
1336          STAA    SIGACQ
1337          STAA    LATCH1
1338 IO1YC1   CLR     FMSDO1
1339          LDAA    #2
1340          STAA    MSDO1
1341          STAA    FLBFG1
1342          JMP     IO1G
1343 IO1YD    LDAA    FLBFG1
1344          BEQ     IO1YF
1345          STAA    XFER1
1346          LDAA    CHCT1+1
1347          CMPA    #10       RCV ELASTIC BUFFER FULL?
1348          BGE     IO1YE
1349          JMP     IO2PT
1350 IO1YE    CLR     FLBFG1
1351          STAA    UT1
1352          LDAA    SIGACQ    SET OUTPUT MODE
1353          ANDA    #0EFH
1354          STAA    SIGACQ
1355          STAA    LATCH1
1356          LDAA    MRFTA
1357          ANDA    #0FEH      CLR RESET ON I/O FIFO
1358          STAA    MRFTA
1359          STAA    LATCH3
1360          JSR     LD1
```

```
1361         JSR    LD1       LOAD FIFO W/6 BUF. CH.
1362         LDAA   BPS16K
1363         BEQ    IO1YE0
1364         JSR    LD1       16KBPS SO:
1365         JSR    LD1
1366         JSR    LD1
1367         JSR    LD1
1368         JSR    LD1       LOAD FIFO WITH 21 BUF. CH.
1369 IO1YE0  JMP    IO2PT
1370 IO1YE1  LDAA   #1
1371         STAA   XFER1
1372         LDAA   UT1
1373         BNE    IO1YE0
1374         LDAA   DATA6     CHECK FIFO UNDERFLOW
1375         BITA   #8        BY TESTING FIFO "O.R."
1376         BEQ    IO1YC1    **UNDERFLOW**
1377         JMP    IO2PT
1378 IO1YF   LDX    CHCT1
1379         BEQ    IO1YE1
1380         LDAA   DATA6
1381         LDAB   UT1
1382         BNE    IO1YFA
1383         BITA   #8
1384         BEQ    IO1YC1
1385 IO1YFA  BITA   #080H     CHECK FIFO "I.R.":  FULL?
1386         BEQ    IO2PT
1387 IO1YG   JSR    IO1LF     OUTPUT 1 CH. TO FIFO
1388         LDAA   DATA6
1389         BITA   #080H     CHECK "I.R.": FULL?
1390         BEQ    IO2PT
1391 IO1YH   JSR    IO1LF     OUTPUT 2 CH. TO FIFO
1392         LDAA   DATA6
1393         BITA   #080H     CHECK "I.R.": FULL?
1394         BEQ    IO2PT
1395 IO1YI   JSR    IO1LF     OUTPUT 3 CH. TO FIFO
1396         LDAA   BPS16K
1397         BEQ    IO2PT
1398 IO1YJ   LDAA   DATA6     16KBPS: SERVICE 10 CHARS.
1399         BITA   #080H     CHECK "I.R.": FULL?
1400         BEQ    IO2PT
1401 IO1YK   JSR    IO1LF     OUTPUT 4 CH. TO FIFO
1402         LDAA   DATA6
1403         BITA   #080H     CHECK "I.R.": FULL?
1404         BEQ    IO2PT
1405 IO1YL   JSR    IO1LF     OUTPUT 5 CH. TO FIFO
1406         LDAA   DATA6
1407         BITA   #080H     CHECK "I.R.": FULL?
1408         BEQ    IO2PT
1409 IO1YM   JSR    IO1LF     OUTPUT 6 CH. TO FIFO
1410         LDAA   DATA6
1411         BITA   #080H     CHECK "I.R.": FULL?
1412         BEQ    IO2PT
1413 IO1YN   JSR    IO1LF     OUTPUT 7 CH. TO FIFO
1414         LDAA   DATA6
1415         BITA   #080H     CHECK "I.R.": FULL?
1416         BEQ    IO2PT
1417 IO1YO   JSR    IO1LF     OUTPUT 8 CH. TO FIFO
```

```
1418         LDAA   DATA6
1419         BITA   #080H     CHECK "I.R.": FULL?
1420         BEQ    IO2PT
1421 IO1YP   JSR    IO1LF     OUTPUT 9 CH. TO FIFO
1422         LDAA   DATA6
1423         BITA   #080H     CHECK "I.R.": FULL?
1424         BEQ    IO2PT
1425 IO1YQ   JSR    IO1LF     OUTPUT 10 CH. TO FIFO
1426 ************************************************************
1427 *
1428 *
1429 *
1430 IO2PT   LDAA   PTONRX    PORT #2 ON?
1431         ANDA   #2
1432         BEQ    IO2A1
1433         CLR    P2OFF
1434         JMP    IO2A
1435 IO2A1   LDAA   P2OFF     PORT IS OFF
1436         BEQ    IO2A2
1437         JMP    IO3PT
1438 IO2A2   STAA   CHCT2
1439         STAA   CHCT2+1
1440         STAA   XMTRQ2
1441         STAA   UT2
1442         LDX    #0
1443         STX    LGDPT2
1444         STAA   OUFG2
1445         STAA   EMPTY2
1446         LDAA   #2
1447         STAA   MSDO2
1448         INCA
1449         STAA   FLBFG2
1450         LDAA   MRFTA
1451         ORAA   #2        RESET FIFO I/O #2
1452         ANDA   #0DFH
1453         STAA   MRFTA
1454         STAA   LATCH3
1455         STAA   P2OFF
1456         LDAA   PA1AD
1457         ANDA   #0FDH      CLEAR "DATA RDY PORT #2"
1458         STAA   PA1AD
1459         STAA   PIA1AD
1460         LDX    #SBUFF2
1461         STX    INPT2
1462         STX    OUTPT2
1463         LDAA   SIGACQ    CLR "SIGNAL ACQ. I/O #2"
1464         ANDA   #0FDH
1465         STAA   SIGACQ
1466         STAA   LATCH1
1467         LDX    TXPNTR
1468         CPX    #INPT2
1469         BNE    IO2A3
1470         CLR    SOEN
1471 IO2A3   JMP    IO3PT
1472 ************************************************************
1473 *
1474 *    INPUT SERVICE ROUTINE
```

```
1475 *
1476 IO2LS  LDAA   #1
1477        STAA   XFER2
1478        LDAA   IO2       OBTAIN CHAR
1479        LDX    INPT2     GET PUT PNTR
1480        STAA   0,X       PUT IT
1481        INX              INCR PUT PNTR
1482        CPX    OUTPT2    TEST OVERFLOW
1483        BNE    IO2LSX    BRANCH NO OVERFLOW
1484        LDAA   MRFTA     **OVERFLOW**
1485        ANDA   #0DFH      CLR "XMT ACK"
1486        ORAA   #2        RESET FIFO
1487        STAA   MRFTA
1488        STAA   LATCH3
1489        STAA   OUFG2     SET OUFG FLAG
1490        INS              *REMOVE RETURN
1491        INS              *
1492        JMP    IO3PT
1493 IO2LSX LDAA   BPS16K
1494        BEQ    IO2LSA
1495        CPX    #EBUFF4    16 KBPS
1496        BNE    IO2LSB
1497        LDX    #SBUFF1
1498        BRA    IO2LSB
1499 IO2LSA CPX    #EBUFF2    TEST END OF INPUT
1500        BNE    IO2LSB    NO
1501        LDX    #SBUFF2    GET INITIAL VALUE
1502 IO2LSB STX    INPT2
1503        LDX    CHCT2     GET CHAR COUNT
1504        INX              INCR COUNT
1505        STX    CHCT2     PUT BACK
1506        RTS
1507 ************************************************************
1508 *
1509 *LOAD I/O #2 FIFO WITH 1 CHAR ROUTINE
1510 *
1511 IO2LF  LDX    OUTPT2
1512        LDAA   RXINHB                                        WBR
1513        BITA   #2        IS THE EXTEND TRANSMIT FLAG SET?    WBR
1514        BNE    IO2LF1    YES:RX NOT ALLOWED                  WBR
1515        LDAA   0,X
1516        STAA   IO2+2     OUTPUT CH. TO I/O #2 FIFO
1517 IO2LF1 INX              ADJ. OUTPUT PNTR.
1518        LDAB   BPS16K
1519        BEQ    IO2LFA
1520        CPX    #EBUFF4    16 KBPS
1521        BNE    IO2LFB
1522        LDX    #SBUFF1
1523        BRA    IO2LFB
1524 IO2LFA CPX    #EBUFF2
1525        BNE    IO2LFB
1526        LDX    #SBUFF2
1527 IO2LFB STX    OUTPT2
1528        LDAA   #1
1529        STAA   XFER2
1530        LDAA   FMSDO2    TEST MISSING DO
1531        BEQ    IO2LFC
```

```
1532         LDX    MDOCT2
1533         DEX
1534         STX    MDOCT2
1535         BNE    IO2LFC
1536         LDAA   SIGACQ
1537         ANDA   #0FDH
1538         STAA   SIGACQ
1539         STAA   LATCH1
1540         CLR    FMSDO2
1541 IO2LFC  LDX    CHCT2     ADJUST CHAR COUNT
1542         DEX
1543         STX    CHCT2
1544         BNE    IO2LFD
1545         INS               REMOVE RETURN
1546         INS
1547         JMP    IO2YE1    GO CHECK UNDERFLOW
1548 IO2LFD  RTS
1549 ************************************************************
1550 *
1551 * LOAD FIFO I/O #2 WITH 3 BUF. CH. ROUTINE
1552 *
1553 LD2      LDX    OUTPT2
1554         LDAA   0,X
1555         STAA   IO2+2
1556         LDAA   1,X
1557         STAA   IO2+2
1558         LDAA   2,X
1559         STAA   IO2+2
1560         INX
1561         INX
1562         INX
1563         STX    OUTPT2
1564         LDX    CHCT2
1565         DEX
1566         DEX
1567         DEX
1568         STX    CHCT2
1569         RTS
1570 ************************************************************
1571 *
1572 *****  BEGIN SERVICING I/O PORT #2   *****
1573 *
1574 IO2A    LDAA   PTONRX    RX ONLY?
1575         BITA   #020H
1576         BEQ    IO2AA
1577         JMP    IO2Y
1578 IO2AA   LDAA   DATA1
1579         BITA   #2
1580         BNE    IO2B
1581         JMP    IO2Y
1582 IO2B    ASLA
1583         BPL    IO2C
1584         LDAA   XMTRQ2
1585         BNE    IO2C
1586         LDAA   EMPTY2
1587         BNE    IO2CA
1588         LDX    CHCT2     R/T SELECTED: CHECK RCV DON
```

```
1589         BEQ    IO2BB
1590 IO2BA   JMP    IO2YD
1591 IO2BB   LDAA   DATA6    TEST: I/O FIFO UNDERFLOW
1592         BITA   #4
1593         BNE    IO2BA    BRANCH: NO UNDERFLOW
1594 IO2C    LDAA   XMTRQ2
1595         BNE    IO2D
1596         LDAA   EMPTY2
1597         BEQ    IO2E
1598 IO2CA   CLR    EMPTY2   GET HERE W/MULTPLE
1599         STAA   XMTRQ2   TX REQ PER FRAME
1600         LDX    #0
1601         STX    LGDPT2
1602         LDAA   MRFTA
1603         ORAA   #020H     SET "TX ACK"
1604         STAA   MRFTA
1605         STAA   LATCH3
1606 IO2D    LDAA   OUFG2
1607         BNE    IO2DA
1608         JMP    IO2H
1609 IO2DA   STAA   XFER2
1610         JMP    IO3PT
1611 IO2E    LDAA   DATA5    CHECK TX INHIBIT
1612         ANDA   #1
1613         BEQ    IO2F
1614         JMP    IO3PT
1615 IO2F    LDAA   #1       **INIT FOR PORT #2**
1616         STAA   XMTRQ2   **DATA TRANSMISSION**
1617         STAA   GROUP2
1618         STAA   XFER2
1619         STAA   FLBFG2
1620         LDAA   SIGACQ
1621         ORAA   #020H     SELECT I/O INPUT MODE
1622         ANDA   #0FDH     CLR "SIG. ACQ. #2"
1623         STAA   SIGACQ
1624         STAA   LATCH1
1625         LDAA   MRFTA
1626         ORAA   #2       TOGGLE FIFO'S RESET
1627         STAA   LATCH3
1628         CLR    IO2+2    CLR PIA B-SIDE
1629         ANDA   #0FDH
1630         ORAA   #020H     SET "XMT ACK" I/O #2
1631         STAA   MRFTA
1632         STAA   LATCH3
1633         LDAA   BPS16K
1634         BEQ    IO2FA
1635         LDX    #SBUFF1+6   16KBPS
1636         STX    INPT2
1637         LDX    #SBUFF1
1638         BRA    IO2FB
1639 IO2FA   LDX    #SBUFF2+6
1640         STX    INPT2
1641         LDX    #SBUFF2
1642 IO2FB   STX    OUTPT2
1643         LDAA   #0FFH     STUFF 6 ELASTIC
1644         STAA   0,X      BUFFER CHARACTERS (CC)
1645         STAA   1,X
```

```
1646          STAA   2,X
1647          STAA   3,X
1648          STAA   4,X
1649          STAA   5,X
1650          LDX    #6
1651          STX    CHCT2
1652          JMP    IO3PT
1653 IO2G     LDAA   BPS16K
1654          BEQ    IO2GA
1655          LDX    #SBUFF1   16KBPS
1656          BRA    IO2GB
1657 IO2GA    LDX    #SBUFF2
1658 IO2GB    STX    INPT2
1659          STX    OUTPT2
1660          LDX    #0
1661          STX    CHCT2
1662          LDAA   SIGACQ    CLR "SIGNAL ACQ. I/O #2"
1663          ANDA   #0FDH
1664          STAA   SIGACQ
1665          STAA   LATCH1
1666          JMP    IO3PT
1667 IO2H     LDAA   DATA5     CHECK TX INHIBIT
1668          ANDA   #1
1669          BEQ    IO2HA
1670          JMP    IO2YA1
1671 IO2HA    LDAB   FLBFG2
1672          BEQ    IO2HB
1673          JMP    IO2O
1674 IO2HB    LDAA   DATA6     TEST FIFO "O.R."
1675          BITA   #4
1676          BNE    IO2I
1677          JMP    IO2XP
1678 IO2I     JSR    IO2LS     LOAD & STORE 1 CHAR
1679          LDAA   DATA6
1680          BITA   #4
1681          BNE    IO2K
1682          JMP    IO2XP
1683 IO2K     JSR    IO2LS     LOAD & STORE 2 CHAR
1684          LDAA   DATA6
1685          BITA   #4
1686          BNE    IO2M
1687          JMP    IO2XP
1688 IO2M     JSR    IO2LS     LOAD & STORE 3 CHAR
1689          LDAA   DATA6
1690          BITA   #4
1691          BNE    IO2N2
1692          JMP    IO2XP
1693 IO2N2    JSR    IO2LS     LOAD & STORE 4 CHAR
1694          LDAA   BPS16K
1695          BNE    IO2N3
1696          JMP    IO2XP
1697 IO2N3    LDAA   DATA6     *16KBPS:  ALLOW MORE*
1698          BITA   #4        *I/O SERVICING*
1699          BNE    IO2N4
1700          JMP    IO2XP
1701 IO2N4    JSR    IO2LS     LOAD & STORE 5 CHAR.
1702          LDAA   DATA6
```

```
1703          BITA    #4
1704          BNE     IO2N5
1705          JMP     IO2XP
1706 IO2N5    JSR     IO2LS     LOAD & STORE 6 CHAR.
1707          LDAA    DATA6
1708          BITA    #4
1709          BNE     IO2N6
1710          JMP     IO2XP
1711 IO2N6    JSR     IO2LS     LOAD & STORE 7 CHAR.
1712          LDAA    DATA6
1713          BITA    #4
1714          BNE     IO2N7
1715          JMP     IO2XP
1716 IO2N7    JSR     IO2LS     LOAD & STORE 8 CHAR.
1717          LDAA    DATA6
1718          BITA    #4
1719          BNE     IO2N8
1720          JMP     IO2XP
1721 IO2N8    JSR     IO2LS     LOAD & STORE 9 CHAR.
1722          LDAA    DATA6
1723          BITA    #4
1724          BNE     IO2N9
1725          JMP     IO2XP
1726 IO2N9    JSR     IO2LS     LOAD & STORE 10 CHAR.
1727          LDAA    DATA6
1728          BITA    #4
1729          BNE     IO2N10
1730          JMP     IO2XP
1731 IO2N10   JSR     IO2LS     LOAD & STORE 11 CHAR.
1732          JMP     IO2XP
1733 IO2O     LDAA    DATA6
1734          BITA    #4
1735          BEQ     IO2XP
1736 IO2P     CLR     FLBFG2
1737          LDAA    PA1AD     SET "DATA RDY PORT #2"
1738          ORAA    #2
1739          STAA    PA1AD
1740          STAA    PIA1AD
1741          JMP     IO2I
1742 IO2XP    LDAA    EMPTY2    **TEST IF SETUP**
1743          BPL     IO2XQ     **LAST GOOD DATA PNTR**
1744          LDX     INPT2     DO SETUP
1745          STX     LGDPT2
1746          LDAA    #1
1747          STAA    EMPTY2
1748 IO2XQ    JMP     IO3PT
1749 IO2Y     LDAA    XMTRQ2
1750          BEQ     IO2YB
1751          LDAA    MRFTA
1752          ANDA    #0DFH      CLR "TX ACK"
1753          STAA    MRFTA
1754          STAA    LATCH3
1755          CLR     XMTRQ2    FIRST TIME THAT
1756          LDAA    #0FFH      TX REQ = FALSE
1757          STAA    EMPTY2
1758          LDAA    PA1AD
1759          ANDA    #2
```

```
1760          BNE    IO2YA
1761          STAA   CHCT2       NO DATA:  ABORT INPUT
1762          STAA   CHCT2+1
1763          STAA   EMPTY2
1764          INCA
1765          STAA   FLBFG2
1766          LDAA   MRFTA
1767          ORAA   #2
1768          STAA   MRFTA
1769          STAA   LATCH3
1770          JMP    IO3PT
1771 IO2YA    JMP    IO2D
1772 IO2YB    LDAA   EMPTY2
1773          BNE    IO2YA
1774          JMP    IO2YD
1775 IO2YA1   CLRA
1776          STAA   XMTRQ2
1777          STAA   EMPTY2
1778          LDAA   PA1AD
1779          ANDA   #0FDH
1780          STAA   PIA1AD    CLEAR "DATA RDY PORT #2"
1781          STAA   PA1AD
1782          LDAA   MRFTA
1783          ORAA   #2        RESET I/O #2 FIFO
1784          ANDA   #0DFH      CLR TX ACK I/O #2
1785          STAA   MRFTA
1786          STAA   LATCH3
1787 IO2YC    LDAA   MRFTA     **INIT I/O PORT**
1788          ORAA   #2        **TO OUTPUT**
1789          STAA   MRFTA     **RX BURST DATA**
1790          STAA   LATCH3    RESET I/O #2 FIFO
1791          LDAA   SIGACQ
1792          ANDA   #0DFH      SELECT I/O OUTPUT MODE
1793          STAA   SIGACQ
1794          STAA   LATCH1
1795 IO2YC1   CLR    FMSDO2
1796          LDAA   #2
1797          STAA   MSDO2
1798          STAA   FLBFG2
1799          JMP    IO2G
1800 IO2YD    LDAA   FLBFG2
1801          BEQ    IO2YF
1802          STAA   XFER2
1803          LDAA   CHCT2+1
1804          CMPA   #10       RCV ELASTIC BUFFER FULL?
1805          BGE    IO2YE
1806          JMP    IO3PT
1807 IO2YE    CLR    FLBFG2
1808          STAA   UT2
1809          LDAA   SIGACQ    SET OUTPUT MODE
1810          ANDA   #0DFH
1811          STAA   SIGACQ
1812          STAA   LATCH1
1813          LDAA   MRFTA
1814          ANDA   #0FDH      CLR REST ON I/O FIFO
1815          STAA   MRFTA
1816          STAA   LATCH3
```

```
1817         JSR    LD2
1818         JSR    LD2       LOAD FIFO W/6 BUF. CH.
1819         LDAA   BPS16K
1820         BEQ    IO2YE0
1821         JSR    LD2       16 KBPS SO:
1822         JSR    LD2
1823         JSR    LD2
1824         JSR    LD2
1825         JSR    LD2       LOAD FIFO W/21 BUF. CH.
1826 IO2YE0  JMP    IO3PT
1827 IO2YE1  LDAA   #1
1828         STAA   XFER2
1829         LDAA   UT2
1830         BNE    IO2YE0
1831         LDAA   DATA6     CHECK FIFO UNDERFLOW
1832         BITA   #4        BY TESTING FIFO "O.R."
1833         BEQ    IO2YC1    **UNDERFLOW**
1834         JMP    IO3PT
1835 IO2YF   LDX    CHCT2
1836         BEQ    IO2YE1
1837         LDAA   DATA6
1838         LDAB   UT2
1839         BNE    IO2YFA
1840         BITA   #4
1841         BEQ    IO2YC1
1842 IO2YFA  BITA   #040H     CHECK FIFO "I.R.":  FULL?
1843         BEQ    IO3PT
1844 IO2YG   JSR    IO2LF     OUTPUT 1 CH. TO FIFO
1845         LDAA   DATA6
1846         BITA   #040H     CHECK "I.R.": FULL?
1847         BEQ    IO3PT
1848 IO2YH   JSR    IO2LF     OUTPUT 2 CH. TO FIFO
1849         LDAA   DATA6
1850         BITA   #040H     CHECK "I.R.":  FULL?
1851         BEQ    IO3PT
1852 IO2YI   JSR    IO2LF     OUTPUT 3 CH. TO FIFO
1853         LDAA   BPS16K
1854         BEQ    IO3PT
1855 IO2YJ   LDAA   DATA6     16 KBPS:  SERVICE 10 CHARS.
1856         BITA   #040H     CHECK "I.R.": FULL?
1857         BEQ    IO3PT
1858 IO2YK   JSR    IO2LF     OUTPUT 4 CH. TO FIFO
1859         LDAA   DATA6
1860         BITA   #040H     CHECK "I.R.": FULL?
1861         BEQ    IO3PT
1862 IO2YL   JSR    IO2LF     OUTPUT 5 CH. TO FIFO
1863         LDAA   DATA6
1864         BITA   #040H     CHECK "I.R.": FULL?
1865         BEQ    IO3PT
1866 IO2YM   JSR    IO2LF     OUTPUT 6 CH. TO FIFO
1867         LDAA   DATA6
1868         BITA   #040H     CHECK "I.R.": FULL?
1869         BEQ    IO3PT
1870 IO2YN   JSR    IO2LF     OUTPUT 7 CH. TO FIFO
1871         LDAA   DATA6
1872         BITA   #040H     CHECK "I.R.": FULL?
1873         BEQ    IO3PT
```

```
1874 IO2YO  JSR    IO2LF    OUTPUT 8 CH. TO FIFO
1875        LDAA   DATA6
1876        BITA   #040H     CHECK "I.R.": FULL?
1877        BEQ    IO3PT
1878 IO2YP  JSR    IO2LF    OUTPUT 9 CH. TO FIFO
1879        LDAA   DATA6
1880        BITA   #040H     CHECK "I.R.": FULL?
1881        BEQ    IO3PT
1882 IO2YQ  JSR    IO2LF    OUTPUT 10 CH. TO FIFO
1883 ************************************************************
1884 *
1885 *
1886 *
1887 IO3PT  LDAA   PTONRX   PORT #3 ON?
1888        ANDA   #4
1889        BEQ    IO3A1
1890        CLR    P3OFF
1891        JMP    IO3A
1892 IO3A1  LDAA   P3OFF    PORT IS OFF
1893        BEQ    IO3A2
1894        JMP    IO4PT
1895 IO3A2  STAA   CHCT3
1896        STAA   CHCT3+1
1897        STAA   XMTRQ3
1898        STAA   UT3
1899        LDX    #0
1900        STX    LGDPT3
1901        STAA   OUFG3
1902        STAA   EMPTY3
1903        LDAA   #2
1904        STAA   MSDO3
1905        INCA
1906        STAA   FLBFG3
1907        LDAA   MRFTA
1908        ORAA   #4       RESET FIFO I/O #3
1909        ANDA   #0BFH     CLR XMT ACK I/O #3
1910        STAA   MRFTA
1911        STAA   LATCH3
1912        STAA   P3OFF
1913        LDAA   PA1AD
1914        ANDA   #0FBH     CLEAR "DATA RDY PORT #3"
1915        STAA   PA1AD
1916        STAA   PIA1AD
1917        LDX    #SBUFF3
1918        STX    INPT3
1919        STX    OUTPT3
1920        LDAA   SIGACQ   CLR "SIGNAL ACQ. I/O #3"
1921        ANDA   #0FBH
1922        STAA   SIGACQ
1923        STAA   LATCH1
1924        LDX    TXPNTR
1925        CPX    #INPT3
1926        BNE    IO3A3
1927        CLR    SOEN
1928 IO3A3  JMP    IO4PT
1929 ************************************************************
1930 *
```

```
1931 *   INPUT SERVICE SUBROUTINE
1932 *
1933 IO3LS  LDAA   #1
1934        STAA   XFER3
1935        LDAA   IO3       OBTAIN CHAR
1936        LDX    INPT3     GET PUT PNTR
1937        STAA   0,X       PUT IT
1938        INX              INCR PUT PNTR
1939        CPX    OUTPT3    TEST OVERFLOW
1940        BNE    IO3LSX    BRANCH NO OVERFLOW
1941        LDAA   MRFTA     **OVERFLOW**
1942        ANDA   #0BFH      CLR XMT ACK I/O #3
1943        ORAA   #4        RESET FIFO I/O #3
1944        STAA   MRFTA
1945        STAA   LATCH3
1946        STAA   OUFG3     SET OUFG FLAG
1947        INS              *REMOVE RETURN
1948        INS              *
1949        JMP    IO4PT
1950 IO3LSX LDAA   BPS16K
1951        BEQ    IO3LSA
1952        CPX    #EBUFF4    16 KBPS
1953        BNE    IO3LSB
1954        LDX    #SBUFF1
1955        BRA    IO3LSB
1956 IO3LSA CPX    #EBUFF3    TEST END OF INPUT
1957        BNE    IO3LSB    NO
1958        LDX    #SBUFF3    GET INITIAL VALUE
1959 IO3LSB STX    INPT3
1960        LDX    CHCT3     GET CHAR. COUNT
1961        INX              INCR COUNT
1962        STX    CHCT3     PUT BACK
1963        RTS
1964 ************************************************************
1965 *
1966 *LOAD I/O #3 FIFO WITH 1 CHAR. ROUTINE
1967 *
1968 IO3LF  LDX    OUTPT3
1969        LDAA   RXINHB                                        WBR
1970        BITA   #4        IS THE EXTEND TRANSMIT FLAG SET?    WBR
1971        BNE    IO3LF1    YES:RX NOT ALLOWED                  WBR
1972        LDAA   0,X
1973        STAA   IO3+2     OUTPUT CH. TO I/O #3 FIFO
1974 IO3LF1 INX              ADJ. OUTPUT PNTR.
1975        LDAB   BPS16K
1976        BEQ    IO3LFA
1977        CPX    #EBUFF4    16KBPS
1978        BNE    IO3LFB
1979        LDX    #SBUFF1
1980        BRA    IO3LFB
1981 IO3LFA CPX    #EBUFF3
1982        BNE    IO3LFB
1983        LDX    #SBUFF3
1984 IO3LFB STX    OUTPT3
1985        LDAA   #1
1986        STAA   XFER3
1987        LDAA   FMSDO3    TEST MISSING DO
```

```
1988         BEQ    IO3LFC
1989         LDX    MDOCT3
1990         DEX
1991         STX    MDOCT3
1992         BNE    IO3LFC
1993         LDAA   SIGACQ
1994         ANDA   #0FBH
1995         STAA   SIGACQ
1996         STAA   LATCH1
1997         CLR    FMSDO3
1998 IO3LFC LDX    CHCT3     ADJ CHAR. COUNT
1999         DEX
2000         STX    CHCT3
2001         BNE    IO3LFD
2002         INS               REMOVE RETURN
2003         INS
2004         JMP    IO3YE1    GO CHECK UNDERFLOW
2005 IO3LFD RTS
2006 ************************************************************
2007 *
2008 *LOAD FIFO I/O #3 WITH 3 BUF. CH. ROUTINE
2009 *
2010 LD3     LDX    OUTPT3
2011         LDAA   0,X
2012         STAA   IO3+2
2013         LDAA   1,X
2014         STAA   IO3+2
2015         LDAA   2,X
2016         STAA   IO3+2
2017         INX
2018         INX
2019         INX
2020         STX    OUTPT3
2021         LDX    CHCT3
2022         DEX
2023         DEX
2024         DEX
2025         STX    CHCT3
2026         RTS
2027 ************************************************************
2028 *
2029 *****  BEGIN SERVICING I/O PORT #3    *****
2030 *
2031 IO3A    LDAA   PTONRX    RX ONLY?
2032         BITA   #040H
2033         BEQ    IO3AA
2034         JMP    IO3Y
2035 IO3AA   LDAA   DATA1
2036         BITA   #4
2037         BNE    IO3B
2038         JMP    IO3Y
2039 IO3B    ASLA
2040         BPL    IO3C
2041         LDAA   XMTRQ3
2042         BNE    IO3C
2043         LDAA   EMPTY3
2044         BNE    IO3CA
```

```
2045         LDX    CHCT3     R/T SELECTED: CHECK RCV DON
2046         BEQ    IO3BB
2047 IO3BA   JMP    IO3YD
2048 IO3BB   LDAA   DATA6     TEST: I/O FIFO UNDERFLOW
2049         BITA   #2
2050         BNE    IO3BA     BRANCH:  NO UNDERFLOW
2051 IO3C    LDAA   XMTRQ3
2052         BNE    IO3D
2053         LDAA   EMPTY3
2054         BEQ    IO3E
2055 IO3CA   CLR    EMPTY3    GET HERE W/MULTIPLE
2056         STAA   XMTRQ3    TX REQ PER FRAME
2057         LDX    #0
2058         STX    LGDPT3
2059         LDAA   MRFTA
2060         ORAA   #040H      SET "TX ACK"
2061         STAA   MRFTA
2062         STAA   LATCH3
2063 IO3D    LDAA   OUFG3
2064         BNE    IO3DA
2065         JMP    IO3H
2066 IO3DA   STAA   XFER3
2067         JMP    IO4PT
2068 IO3E    LDAA   DATA5     CHECK TX INHIBIT
2069         ANDA   #1
2070         BEQ    IO3F
2071         JMP    IO4PT
2072 IO3F    LDAA   #1        **INIT FOR PORT #3**
2073         STAA   XMTRQ3    **DATA TRANSMISSION**
2074         STAA   GROUP3
2075         STAA   XFER3
2076         STAA   FLBFG3
2077         LDAA   SIGACQ
2078         ORAA   #040H      SET I/O INPUT MODE
2079         ANDA   #0FBH      CLR "SIG. ACQ. #3"
2080         STAA   SIGACQ
2081         STAA   LATCH1
2082         LDAA   MRFTA
2083         ORAA   #4        TOGGLE FIFO'S RESET
2084         STAA   LATCH3
2085         CLR    IO3+2     CLR PIA-B SIDE
2086         ANDA   #0FBH
2087         ORAA   #040H      SET XMT ACK I/O #3
2088         STAA   MRFTA
2089         STAA   LATCH3
2090         LDAA   BPS16K
2091         BEQ    IO3FA
2092         LDX    #SBUFF1+6   16KBPS
2093         STX    INPT3
2094         LDX    #SBUFF1
2095         BRA    IO3FB
2096 IO3FA   LDX    #SBUFF3+6
2097         STX    INPT3
2098         LDX    #SBUFF3
2099 IO3FB   STX    OUTPT3
2100         LDAA   #0FFH      STUFF 6 ELASTIC
2101         STAA   0,X       BUFFER CHARACTERS (CC)
```

```
2102          STAA    1,X
2103          STAA    2,X
2104          STAA    3,X
2105          STAA    4,X
2106          STAA    5,X
2107          LDX     #6
2108          STX     CHCT3
2109          JMP     IO4PT
2110 IO3G     LDAA    BPS16K
2111          BEQ     IO3GA
2112          LDX     #SBUFF1   16KBPS
2113          BRA     IO3GB
2114 IO3GA    LDX     #SBUFF3
2115 IO3GB    STX     INPT3
2116          STX     OUTPT3
2117          LDX     #0
2118          STX     CHCT3
2119          LDAA    SIGACQ    CLR "SIGNAL ACQ. I/O #3"
2120          ANDA    #0FBH
2121          STAA    SIGACQ
2122          STAA    LATCH1
2123          JMP     IO4PT
2124 IO3H     LDAA    DATA5     CHECK TX INHIBIT
2125          ANDA    #1
2126          BEQ     IO3HA
2127          JMP     IO3YA1
2128 IO3HA    LDAB    FLBFG3
2129          BEQ     IO3HB
2130          JMP     IO3O
2131 IO3HB    LDAA    DATA6     TEST FIFO "O.R."
2132          BITA    #2
2133          BNE     IO3I
2134          JMP     IO3XP
2135 IO3I     JSR     IO3LS     LOAD & STORE 1 CHAR
2136          LDAA    DATA6
2137          BITA    #2
2138          BNE     IO3K
2139          JMP     IO3XP
2140 IO3K     JSR     IO3LS     LOAD & STORE 2 CHAR
2141          LDAA    DATA6
2142          BITA    #2
2143          BNE     IO3M
2144          JMP     IO3XP
2145 IO3M     JSR     IO3LS     LOAD & STORE 3 CHAR
2146          LDAA    DATA6
2147          BITA    #2
2148          BNE     IO3N2
2149          JMP     IO3XP
2150 IO3N2    JSR     IO3LS     LOAD & STORE 4 CHAR
2151          LDAA    BPS16K
2152          BNE     IO3N3
2153          JMP     IO3XP
2154 IO3N3    LDAA    DATA6     *16KBPS:  ALLOW MORE*
2155          BITA    #2        *I/O SERVICING*
2156          BNE     IO3N4
2157          JMP     IO3XP
2158 IO3N4    JSR     IO3LS     LOAD & STORE 5 CHAR.
```

```
2159          LDAA    DATA6
2160          BITA    #2
2161          BNE     IO3N5
2162          JMP     IO3XP
2163 IO3N5    JSR     IO3LS     LOAD & STORE 6 CHAR.
2164          LDAA    DATA6
2165          BITA    #2
2166          BNE     IO3N6
2167          JMP     IO3XP
2168 IO3N6    JSR     IO3LS     LOD & STORE 7 CHAR.
2169          LDAA    DATA6
2170          BITA    #2
2171          BNE     IO3N7
2172          JMP     IO3XP
2173 IO3N7    JSR     IO3LS     LOAD & STORE 8 CHAR.
2174          LDAA    DATA6
2175          BITA    #2
2176          BNE     IO3N8
2177          JMP     IO3XP
2178 IO3N8    JSR     IO3LS     LOAD & STORE 9 CHAR.
2179          LDAA    DATA6
2180          BITA    #2
2181          BNE     IO3N9
2182          JMP     IO3XP
2183 IO3N9    JSR     IO3LS     LOAD & STORE 10 CHAR.
2184          LDAA    DATA6
2185          BITA    #2
2186          BNE     IO3N10
2187          JMP     IO3XP
2188 IO3N10   JSR     IO3LS     LOAD & STORE 11 CHAR.
2189          JMP     IO3XP
2190 IO3O     LDAA    DATA6
2191          BITA    #2
2192          BEQ     IO3XP
2193 IO3P     CLR     FLBFG3
2194          LDAA    PA1AD     SET "DATA RDY PORT #3"
2195          ORAA    #4
2196          STAA    PA1AD
2197          STAA    PIA1AD
2198          JMP     IO3I
2199 IO3XP    LDAA    EMPTY3    **TEST IF SETUP**
2200          BPL     IO3XQ     **LAST GOOD DATA PNTR**
2201          LDX     INPT3     DO SETUP
2202          STX     LGDPT3
2203          LDAA    #1
2204          STAA    EMPTY3
2205 IO3XQ    JMP     IO4PT
2206 IO3Y     LDAA    XMTRQ3
2207          BEQ     IO3YB
2208          LDAA    MRFTA
2209          ANDA    #0BFH      CLR "TX ACK"
2210          STAA    MRFTA
2211          STAA    LATCH3
2212          CLR     XMTRQ3    FIRST TIME THAT
2213          LDAA    #0FFH      TX REQ = FALSE
2214          STAA    EMPTY3
2215          LDAA    PA1AD
```

```
2216          ANDA    #4
2217          BNE     IO3YA
2218          STAA    CHCT3       NO DATA:  ABORT INPUT
2219          STAA    CHCT3+1
2220          STAA    EMPTY3
2221          INCA
2222          STAA    FLBFG3
2223          LDAA    MRFTA
2224          ORAA    #4
2225          STAA    MRFTA
2226          STAA    LATCH3
2227          JMP     IO4PT
2228 IO3YA    JMP     IO3D
2229 IO3YB    LDAA    EMPTY3
2230          BNE     IO3YA
2231          JMP     IO3YD
2232 IO3YA1   CLRA
2233          STAA    XMTRQ3
2234          STAA    EMPTY3
2235          LDAA    PA1AD
2236          ANDA    #0FBH
2237          STAA    PIA1AD    CLEAR "DATA RDY PORT #3"
2238          STAA    PA1AD
2239          LDAA    MRFTA
2240          ORAA    #4        RESET I/O #1 FIFO
2241          ANDA    #0BFH      CLR TX ACK I/O #1
2242          STAA    MRFTA
2243          STAA    LATCH3
2244 IO3YC    LDAA    MRFTA     **INIT I/O PORT**
2245          ORAA    #4        **TO OUTPUT**
2246          STAA    MRFTA     **RX BURST DATA**
2247          STAA    LATCH3    RESET I/O #3 FIFO
2248          LDAA    SIGACQ
2249          ANDA    #0BFH      SELECT I/O OUTPUT MODE
2250          STAA    SIGACQ
2251          STAA    LATCH1
2252 IO3YC1   CLR     FMSDO3
2253          LDAA    #2
2254          STAA    MSDO3
2255          STAA    FLBFG3
2256          JMP     IO3G
2257 IO3YD    LDAA    FLBFG3
2258          BEQ     IO3YF
2259          STAA    XFER3
2260          LDAA    CHCT3+1
2261          CMPA    #10       RCV ELASTIC BUFFER FULL?
2262          BGE     IO3YE
2263          JMP     IO4PT
2264 IO3YE    CLR     FLBFG3
2265          STAA    UT3
2266          LDAA    SIGACQ    SET OUTPUT MODE
2267          ANDA    #0BFH
2268          STAA    SIGACQ
2269          STAA    LATCH1
2270          LDAA    MRFTA
2271          ANDA    #0FBH      CLR RESET ON I/O FIFO
2272          STAA    MRFTA
```

```
2273         STAA   LATCH3
2274         JSR    LD3
2275         JSR    LD3       LOAD FIFO W/6 BUF. CH.
2276         LDAA   BPS16K
2277         BEQ    IO3YE0
2278         JSR    LD3
2279         JSR    LD3
2280         JSR    LD3
2281         JSR    LD3
2282         JSR    LD3       LOAD FIFO W/21 BUF. CH.
2283 IO3YE0  JMP    IO4PT
2284 IO3YE1  LDAA   #1
2285         STAA   XFER3
2286         LDAA   UT3
2287         BNE    IO3YE0
2288         LDAA   DATA6     CHECK FIFO UNDERFLOW
2289         BITA   #2        BY TESTING FIFO "O.R."
2290         BEQ    IO3YC1    **UNDERFLOW**
2291         JMP    IO4PT
2292 IO3YF   LDX    CHCT3
2293         BEQ    IO3YE1
2294         LDAA   DATA6
2295         LDAB   UT3
2296         BNE    IO3YFA
2297         BITA   #2
2298         BEQ    IO3YC1
2299 IO3YFA  BITA   #020H     CHECK "I.R.":  FULL?
2300         BEQ    IO4PT
2301 IO3YG   JSR    IO3LF     OUTPUT 1 CH. TO FIFO
2302         LDAA   DATA6
2303         BITA   #020H     CHECK "I.R.":  FULL?
2304         BEQ    IO4PT
2305 IO3YH   JSR    IO3LF     OUTPUT 2 CH. TO FIFO
2306         LDAA   DATA6
2307         BITA   #020H     CHECK "I.R.": FULL?
2308         BEQ    IO4PT
2309 IO3YI   JSR    IO3LF     OUTPUT 3 CH. TO FIFO
2310         LDAA   BPS16K
2311         BEQ    IO4PT
2312 IO3YJ   LDAA   DATA6     16 KBPS:  SERVICE 10 CHARS.
2313         BITA   #020H     CHECK "I.R.": FULL?
2314         BEQ    IO4PT
2315 IO3YK   JSR    IO3LF     OUTPUT 4 CH. TO FIFO
2316         LDAA   DATA6
2317         BITA   #020H     CHECK "I.R.": FULL?
2318         BEQ    IO4PT
2319 IO3YL   JSR    IO3LF     OUTPUT 5 CH. TO FIFO
2320         LDAA   DATA6
2321         BITA   #020H     CHECK "I.R.": FULL?
2322         BEQ    IO4PT
2323 IO3YM   JSR    IO3LF     OUTPUT 6 CH. TO FIFO
2324         LDAA   DATA6
2325         BITA   #020H     CHECK "I.R.": FULL?
2326         BEQ    IO4PT
2327 IO3YN   JSR    IO3LF     OUTPUT 7 CH. TO FIFO
2328         LDAA   DATA6
2329         BITA   #020H     CHECK "I.R.": FULL?
```

```
2330         BEQ    IO4PT
2331 IO3YO   JSR    IO3LF     OUTPUT 8 CH. TO FIFO
2332         LDAA   DATA6
2333         BITA   #020H      CHECK "I.R.": FULL?
2334         BEQ    IO4PT
2335 IO3YP   JSR    IO3LF     OUTPUT 9 CH. TO FIFO
2336         LDAA   DATA6
2337         BITA   #020H      CHECK "I.R.": FULL?
2338         BEQ    IO4PT
2339 IO3YQ   JSR    IO3LF     OUTPUT 10 CH. TO FIFO
2340 ************************************************************
2341 *
2342 *
2343 *
2344 IO4PT   LDAA   PTONRX    PORT #4 ON?
2345         ANDA   #8
2346         BEQ    IO4A1
2347         CLR    P4OFF
2348         JMP    IO4A
2349 IO4A1   LDAA   P4OFF     PORT IS OFF
2350         BEQ    IO4A2
2351         JMP    BSERV
2352 IO4A2   STAA   CHCT4
2353         STAA   CHCT4+1
2354         STAA   XMTRQ4
2355         STAA   UT4
2356         LDX    #0
2357         STX    LGDPT4
2358         STAA   OUFG4
2359         STAA   EMPTY4
2360         LDAA   #2
2361         STAA   MSDO4
2362         INCA
2363         STAA   FLBFG4
2364         LDAA   MRFTA
2365         ORAA   #8        RESET FIFO I/O #4
2366         ANDA   #07FH      CLR XMT ACK
2367         STAA   MRFTA
2368         STAA   LATCH3
2369         STAA   P4OFF
2370         LDAA   PA1AD
2371         ANDA   #0F7H      CLEAR "DATA RDY PORT #4"
2372         STAA   PA1AD
2373         STAA   PIA1AD
2374         LDX    #SBUFF4
2375         STX    INPT4
2376         STX    OUTPT4
2377         LDAA   SIGACQ    CLR "SIGNAL ACQ. I/O #4"
2378         ANDA   #0F7H
2379         STAA   SIGACQ
2380         STAA   LATCH1
2381         LDX    TXPNTR
2382         CPX    #INPT4
2383         BNE    IO4A3
2384         CLR    SOEN
2385 IO4A3   JMP    BSERV
2386 ************************************************************
```

```
2387 *
2388 *   INPUT SERVICE SUBROUTINE
2389 *
2390 IO4LS  LDAA   #1
2391        STAA   XFER4
2392        LDAA   IO4       OBTAIN CHAR
2393        LDX    INPT4     GET PUT PNTR
2394        STAA   0,X       PUT IT
2395        INX              INCR PUT PNTR
2396        CPX    OUTPT4    TEST OVERFLOW
2397        BNE    IO4LSX    BRANCH NO OVERFLOW
2398        LDAA   MRFTA     **OVERFLOW**
2399        ANDA   #07FH      CLR XMT ACK
2400        ORAA   #8        RESET FIFO
2401        STAA   MRFTA
2402        STAA   LATCH3
2403        STAA   OUFG4     SET OUFG FLAG
2404        INS              *REMOVE RETURN
2405        INS              *
2406        JMP    BSERV
2407 IO4LSX LDAA   BPS16K
2408        BEQ    IO4LSA
2409        CPX    #EBUFF4    16 KBPS
2410        BNE    IO4LSB
2411        LDX    #SBUFF1
2412        BRA    IO4LSB
2413 IO4LSA CPX    #EBUFF4    TEST END OF INPUT
2414        BNE    IO4LSB    NO
2415        LDX    #SBUFF4    GET INITIAL VALUE
2416 IO4LSB STX    INPT4
2417        LDX    CHCT4     GET CHAR COUNT
2418        INX              INCR COUNT
2419        STX    CHCT4     PUT BACK
2420        RTS
2421 ************************************************************
2422 *
2423 *LOAD I/O #4 FIFO WITH 1 CHAR. ROUTINE
2424 *
2425 IO4LF  LDX    OUTPT4
2426        LDAA   RXINHB                                        WBR
2427        BITA   #8        IS THE EXTEND TRANSMIT FLAG SET?    WBR
2428        BNE    IO4LF1    YES:RX NOT ALLOWED                  WBR
2429        LDAA   0,X
2430        STAA   IO4+2     OUTPUT CH. TO I/O #4 FIFO
2431 IO4LF1 INX              ADJ. OUTPUT PNTR.
2432        LDAB   BPS16K
2433        BEQ    IO4LFA
2434        CPX    #EBUFF4    16KBPS
2435        BNE    IO4LFB
2436        LDX    #SBUFF1
2437        BRA    IO4LFB
2438 IO4LFA CPX    #EBUFF4
2439        BNE    IO4LFB
2440        LDX    #SBUFF4
2441 IO4LFB STX    OUTPT4
2442        LDAA   #1
2443        STAA   XFER4
```

```
2444         LDAA    FMSDO4    TEST MISSING DO
2445         BEQ     IO4LFC
2446         LDX     MDOCT4
2447         DEX
2448         STX     MDOCT4
2449         BNE     IO4LFC
2450         LDAA    SIGACQ
2451         ANDA    #0F7H
2452         STAA    SIGACQ
2453         STAA    LATCH1
2454         CLR     FMSDO4
2455 IO4LFC  LDX     CHCT4     ADJUST CHR COUNT
2456         DEX
2457         STX     CHCT4
2458         BNE     IO4LFD
2459         INS               REMOVE RETURN
2460         INS
2461         JMP     IO4YE1    GO CHECK UNDERFLOW
2462 IO4LFD  RTS
2463 ************************************************************
2464 *
2465 *LOAD FIFO I/O #4 WITH 3 BUF. CH. ROUTINE
2466 *
2467 LD4     LDX     OUTPT4
2468         LDAA    0,X
2469         STAA    IO4+2
2470         LDAA    1,X
2471         STAA    IO4+2
2472         LDAA    2,X
2473         STAA    IO4+2
2474         INX
2475         INX
2476         INX
2477         STX     OUTPT4
2478         LDX     CHCT4
2479         DEX
2480         DEX
2481         DEX
2482         STX     CHCT4
2483         RTS
2484 ************************************************************
2485 *
2486 *****  BEGIN SERVICING I/O PORT #4    *****
2487 *
2488 IO4A    LDAA    PTONRX    RX ONLY?
2489         BITA    #080H
2490         BEQ     IO4AA
2491         JMP     IO4Y
2492 IO4AA   LDAA    DATA1
2493         BITA    #8
2494         BNE     IO4B
2495         JMP     IO4Y
2496 IO4B    ASLA
2497         BPL     IO4C
2498         LDAA    XMTRQ4
2499         BNE     IO4C
2500         LDAA    EMPTY4
```

```
2501          BNE     IO4CA
2502          LDX     CHCT4     R/T SELECTED: CHECK RCV DON
2503          BEQ     IO4BB
2504 IO4BA    JMP     IO4YD
2505 IO4BB    LDAA    DATA6     TEST: I/O FIFO UNDERFLOW
2506          BITA    #1
2507          BNE     IO4BA     BRANCH: NO UNDERFLOW
2508 IO4C     LDAA    XMTRQ4
2509          BNE     IO4D
2510          LDAA    EMPTY4
2511          BEQ     IO4E
2512 IO4CA    CLR     EMPTY4    GET HERE W/MULTIPLE
2513          STAA    XMTRQ4    TX REQ PER FRAME
2514          LDX     #0
2515          STX     LGDPT4
2516          LDAA    MRFTA
2517          ORAA    #080H      SET "TX ACK"
2518          STAA    MRFTA
2519          STAA    LATCH3
2520 IO4D     LDAA    OUFG4
2521          BNE     IO4DA
2522          JMP     IO4H
2523 IO4DA    STAA    XFER4
2524          JMP     BSERV
2525 IO4E     LDAA    DATA5     CHECK TX INHIBIT
2526          ANDA    #1
2527          BEQ     IO4F
2528          JMP     BSERV
2529 IO4F     LDAA    #1        **INIT FOR PORT #4**
2530          STAA    XMTRQ4    **DATA TRANSMISSION**
2531          STAA    GROUP4
2532          STAA    XFER4
2533          STAA    FLBFG4
2534          LDAA    SIGACQ
2535          ORAA    #080H      SELECT I/O INPUT MODE
2536          ANDA    #0F7H      CLR "SIG. ACQ. #4"
2537          STAA    SIGACQ
2538          STAA    LATCH1
2539          LDAA    MRFTA
2540          ORAA    #8        TOGGLE FIFO'S RESET
2541          STAA    LATCH3
2542          CLR     IO4+2     CLR PIA-B SIDE
2543          ANDA    #0F7H
2544          ORAA    #080H      SET XMT ACK I/O #4
2545          STAA    MRFTA
2546          STAA    LATCH3
2547          LDAA    BPS16K
2548          BEQ     IO4FA
2549          LDX     #SBUFF1+6    16KBPS
2550          STX     INPT4
2551          LDX     #SBUFF1
2552          BRA     IO4FB
2553 IO4FA    LDX     #SBUFF4+6
2554          STX     INPT4
2555          LDX     #SBUFF4
2556 IO4FB    STX     OUTPT4
2557          LDAA    #0FFH      STUFF 6 ELASTIC
```

```
2558         STAA   0,X      BUFFER CHARACTERS (CC)
2559         STAA   1,X
2560         STAA   2,X
2561         STAA   3,X
2562         STAA   4,X
2563         STAA   5,X
2564         LDX    #6
2565         STX    CHCT4
2566         JMP    BSERV
2567 IO4G    LDAA   BPS16K
2568         BEQ    IO4GA
2569         LDX    #SBUFF1   16 KBPS
2570         BRA    IO4GB
2571 IO4GA   LDX    #SBUFF4
2572 IO4GB   STX    INPT4
2573         STX    OUTPT4
2574         LDX    #0
2575         STX    CHCT4
2576         LDAA   SIGACQ   CLR "SIGNAL ACQ. I/O #4"
2577         ANDA   #0F7H
2578         STAA   SIGACQ
2579         STAA   LATCH1
2580         JMP    BSERV
2581 IO4H    LDAA   DATA5    CHECK TX INHIBIT
2582         ANDA   #1
2583         BEQ    IO4HA
2584         JMP    IO4YA1
2585 IO4HA   LDAB   FLBFG4
2586         BEQ    IO4HB
2587         JMP    IO4O
2588 IO4HB   LDAA   DATA6    TEST FIFO "O.R."
2589         BITA   #1
2590         BNE    IO4I
2591         JMP    IO4XP
2592 IO4I    JSR    IO4LS    LOAD & STORE 1 CHAR
2593         LDAA   DATA6
2594         BITA   #1
2595         BNE    IO4K
2596         JMP    IO4XP
2597 IO4K    JSR    IO4LS    LOAD & STORE 2 CHAR
2598         LDAA   DATA6
2599         BITA   #1
2600         BNE    IO4M
2601         JMP    IO4XP
2602 IO4M    JSR    IO4LS    LOAD $ STORE 3 CHAR.
2603         LDAA   DATA6
2604         BITA   #1
2605         BNE    IO4N2
2606         JMP    IO4XP
2607 IO4N2   JSR    IO4LS    LOAD & STORE 4 CHAR
2608         LDAA   BPS16K
2609         BNE    IO4N3
2610         JMP    IO4XP
2611 IO4N3   LDAA   DATA6    *16 KBPS:  ALLOW MORE*
2612         BITA   #1       *I/O SERVICING*
2613         BNE    IO4N4
2614         JMP    IO4XP
```

```
2615 IO4N4   JSR    IO4LS    LOAD & STORE 5 CHAR.
2616         LDAA   DATA6
2617         BITA   #1
2618         BNE    IO4N5
2619         JMP    IO4XP
2620 IO4N5   JSR    IO4LS    LOAD & STORE 6 CHAR.
2621         LDAA   DATA6
2622         BITA   #1
2623         BNE    IO4N6
2624         JMP    IO4XP
2625 IO4N6   JSR    IO4LS    LOAD & STORE 7 CHAR.
2626         LDAA   DATA6
2627         BITA   #1
2628         BNE    IO4N7
2629         JMP    IO4XP
2630 IO4N7   JSR    IO4LS    LOAD & STORE 8 CHAR.
2631         LDAA   DATA6
2632         BITA   #1
2633         BNE    IO4N8
2634         JMP    IO4XP
2635 IO4N8   JSR    IO4LS    LOAD & STORE 9 CHAR.
2636         LDAA   DATA6
2637         BITA   #1
2638         BNE    IO4N9
2639         JMP    IO4XP
2640 IO4N9   JSR    IO4LS    LOAD & STORE 10 CHAR.
2641         LDAA   DATA6
2642         BITA   #1
2643         BNE    IO4N10
2644         JMP    IO4XP
2645 IO4N10  JSR    IO4LS    LOAD & STORE 11 CHAR.
2646         JMP    IO4XP
2647 IO4O    LDAA   DATA6
2648         BITA   #1
2649         BEQ    IO4XP
2650 IO4P    CLR    FLBFG4
2651         LDAA   PA1AD    SET "DATA RDY PORT #4"
2652         ORAA   #8
2653         STAA   PA1AD
2654         STAA   PIA1AD
2655         JMP    IO4I
2656 IO4XP   LDAA   EMPTY4   **TEST IF SETUP**
2657         BPL    IO4XQ    **LAST GOOD DATA PNTR**
2658         LDX    INPT4    DO SETUP
2659         STX    LGDPT4
2660         LDAA   #1
2661         STAA   EMPTY4
2662 IO4XQ   JMP    BSERV
2663 IO4Y    LDAA   XMTRQ4
2664         BEQ    IO4YB
2665         LDAA   MRFTA
2666         ANDA   #07FH     CLR "TX ACK"
2667         STAA   MRFTA
2668         STAA   LATCH3
2669         CLR    XMTRQ4   FIRST TIME THAT
2670         LDAA   #0FFH     TX REQ = FALSE
2671         STAA   EMPTY4
```

```
2672         LDAA   PA1AD
2673         ANDA   #8
2674         BNE    IO4YA
2675         STAA   CHCT4       NO DATA:  ABORT INPUT
2676         STAA   CHCT4+1
2677         STAA   EMPTY4
2678         INCA
2679         STAA   FLBFG4
2680         LDAA   MRFTA
2681         ORAA   #8
2682         STAA   MRFTA
2683         STAA   LATCH3
2684         JMP    BSERV
2685 IO4YA   JMP    IO4D
2686 IO4YB   LDAA   EMPTY4
2687         BNE    IO4YA
2688         JMP    IO4YD
2689 IO4YA1  CLRA
2690         STAA   XMTRQ4
2691         STAA   EMPTY4
2692         LDAA   PA1AD
2693         ANDA   #0F7H
2694         STAA   PIA1AD    CLEAR "DATA RDY PORT #4"
2695         STAA   PA1AD
2696         LDAA   MRFTA
2697         ORAA   #8        RESET I/O #4 FIFO
2698         ANDA   #07FH      CLR TX ACK I/O #4
2699         STAA   MRFTA
2700         STAA   LATCH3
2701 IO4YC   LDAA   MRFTA     **INIT I/O PORT**
2702         ORAA   #8        **TO OUTPUT**
2703         STAA   MRFTA     **RX BURST DATA**
2704         STAA   LATCH3    RESET I/O #4 FIFO
2705         LDAA   SIGACQ
2706         ANDA   #07FH      SELECT I/O OUTPUT MODE
2707         STAA   SIGACQ
2708         STAA   LATCH1
2709 IO4YC1  CLR    FMSDO4
2710         LDAA   #2
2711         STAA   MSDO4
2712         STAA   FLBFG4
2713         JMP    IO4G
2714 IO4YD   LDAA   FLBFG4
2715         BEQ    IO4YF
2716         STAA   XFER4
2717         LDAA   CHCT4+1
2718         CMPA   #10       RCV ELASTIC BUFFER FULL?
2719         BGE    IO4YE
2720         JMP    BSERV
2721 IO4YE   CLR    FLBFG4
2722         STAA   UT4
2723         LDAA   SIGACQ    SET OUTPUT MODE
2724         ANDA   #07FH
2725         STAA   SIGACQ
2726         STAA   LATCH1
2727         LDAA   MRFTA
2728         ANDA   #0F7H      RESET ON I/O FIFO
```

```
2729          STAA    MRFTA
2730          STAA    LATCH3
2731          JSR     LD4
2732          JSR     LD4       LOAD FIFO W/6 BUF. CH.
2733          LDAA    BPS16K
2734          BEQ     IO4YE0
2735          JSR     LD4       16 KBPS SO:
2736          JSR     LD4
2737          JSR     LD4
2738          JSR     LD4
2739          JSR     LD4       LOAD FIFO W/21 BUF. CH.
2740 IO4YE0   JMP     BSERV
2741 IO4YE1   LDAA    #1
2742          STAA    XFER4
2743          LDAA    UT4
2744          BNE     IO4YE0
2745          LDAA    DATA6     CHECK FIFO UNDERFLOW
2746          BITA    #1        BY TESTING FIFO "O.R."
2747          BEQ     IO4YC1    **UNDERFLOW**
2748          JMP     BSERV
2749 IO4YF    LDX     CHCT4
2750          BEQ     IO4YE1
2751          LDAA    DATA6
2752          LDAB    UT4
2753          BNE     IO4YFA
2754          BITA    #1
2755          BEQ     IO4YC1
2756 IO4YFA   BITA    #010H      CHECK "I.R.":  FULL?
2757          BEQ     BSERV
2758 IO4YG    JSR     IO4LF     OUTPUT 1 CHAN. TO FIFO
2759          LDAA    DATA6
2760          BITA    #010H      CHECK "I.R.":  FULL?
2761          BEQ     BSERV
2762 IO4YH    JSR     IO4LF     OUTPUT 2 CH. TO FIFO
2763          LDAA    DATA6
2764          BITA    #010H      CHECK "I.R.": FULL?
2765          BEQ     BSERV
2766 IO4YI    JSR     IO4LF     OUTPUT 3 CH. TO FIFO
2767          LDAA    BPS16K
2768          BEQ     BSERV
2769 IO4YJ    LDAA    DATA6     16KBPS:  SERVICE 10 CHAR.
2770          BITA    #010H      CHECK "I.R.": FULL?
2771          BEQ     BSERV
2772 IO4YK    JSR     IO4LF     OUTPUT 4 CH. TO FIFO
2773          LDAA    DATA6
2774          BITA    #010H      CHECK "I.R.": FULL?
2775          BEQ     BSERV
2776 IO4YL    JSR     IO4LF     OUTPUT 5 CH. TO FIFO
2777          LDAA    DATA6
2778          BITA    #010H      CHECK "I.R.": FULL?
2779          BEQ     BSERV
2780 IO4YM    JSR     IO4LF     OUTPUT 6 CH. TO FIFO
2781          LDAA    DATA6
2782          BITA    #010H      CHECK "I.R.": FULL?
2783          BEQ     BSERV
2784 IO4YN    JSR     IO4LF     OUTPUT 7 CH. TO FIFO
2785          LDAA    DATA6
```

```
2786         BITA   #010H     CHECK "I.R.": FULL?
2787         BEQ    BSERV
2788 IO4YO   JSR    IO4LF     OUTPUT 8 CH. TO FIFO
2789         LDAA   DATA6
2790         BITA   #010H     CHECK "I.R.": FULL?
2791         BEQ    BSERV
2792 IO4YP   JSR    IO4LF     OUTPUT 9 CH. TO FIFO
2793         LDAA   DATA6
2794         BITA   #010H     CHECK "I.R.": FULL?
2795 IO4YQ   JSR    IO4LF     OUTPUT 10 CH. TO FIFO
2796 ************************************************************
2797 *
2798 *   BITE SERVICE ROUTINE
2799 *
2800 *
2801 BSERV   LDAA   DATA5
2802         BITA   #8        TEST:  SYSTEM BITE RESET
2803         BEQ    BSERVA
2804         CLR    IRSBIT
2805         CLR    BITELT
2806 BSERVA  BITA   #04H      TEST:  LAMP TEST
2807         BEQ    BSERVB
2808         LDAA   #0FFH     TURN ALL BITE LITES ON
2809         BRA    BSERVC                                        WBR
2810 *                        WHEN THE EXTEND TIMER IS SET,       WBR
2811 *                        IT IS NOT AN ERROR FOR THE PORT     WBR
2812 *                        OUTPUT TO BE DIFFERENT FROM THE     WBR
2813 *                        FRAME INPUT, BECAUSE WE ARE         WBR
2814 *                        DISABLING RECEIVE CAPABILITIES.     WBR
2815 *                        THEREFORE WE MUST MASK OUT THE      WBR
2816 *                        ERROR ONLY ON THE PORTS WITH        WBR
2817 *                        THE EXTEND TIMER SET.  BITS 0-3     WBR
2818 *                        IN RXINHB COORESPOND TO PORTS 1-4   WBR
2819 *                        AND BITS 1-4 COORESPOND TO PORTS    WBR
2820 *                        1-4 IN LATCH2.                      WBR
2821 BSERVB LDAA   RXINHB    NO ERROR FOR PORT WITH              WBR
2822         ASLA                  EXTEND TIMER SET             WBR
2823         COMA                                               WBR
2824         ANDA   BITELT    OUTPUT ALL OTHER ERRORS PRESENT    WBR
2825         STAA   BITELT                                       WBR
2826 BSERVC STAA   LATCH2                                        WBR
2827         LDAB   DATA5
2828         LDAA   TIMEFG
2829         BEQ    BSERVF
2830         BITB   #010H     TEST 75/16 HZ CLOCK
2831         BNE    BSERVE
2832 BSERVD CLR    TIMEFG
2833 BSERVE JMP    SOF
2834 BSERVF BITB   #010H     TEST 75/16 HZ CLOCK
2835         BEQ    BSERVE
2836         INC    TIMEFG
2837         LDAB   BITELT
2838         LDX    CHCT1
2839         BEQ    SERVF3
2840 SERVF1 LDAA   XFER1
2841         BEQ    SERVF2
2842         CLR    XFER1
```

```
2843         BRA     BSERVG
2844 SERVF2 ORAB     #2          I/O #1 BITE ERROR
2845         BRA     BSERVG
2846 SERVF3 LDAA     XMTRQ1      NO DATA AFTER TX REQ?
2847         BNE     SERVF1
2848 BSERVG LDX      CHCT2
2849         BEQ     SERVG3
2850 SERVG1 LDAA     XFER2
2851         BEQ     SERVG2
2852         CLR     XFER2
2853         BRA     BSERVH
2854 SERVG2 ORAB     #4          I/O #2 BITE ERROR
2855         BRA     BSERVH
2856 SERVG3 LDAA     XMTRQ2      NO DATA AFTER TX REQ?
2857         BNE     SERVG1
2858 BSERVH LDX      CHCT3
2859         BEQ     SERVH3
2860 SERVH1 LDAA     XFER3
2861         BEQ     SERVH2
2862         CLR     XFER3
2863         BRA     BSERVI
2864 SERVH2 ORAB     #8          I/O #3 BITE ERROR
2865         BRA     BSERVI
2866 SERVH3 LDAA     XMTRQ3      NO DATA AFTER TX REQ?
2867         BNE     SERVH1
2868 BSERVI LDX      CHCT4
2869         BEQ     SERVI3
2870 SERVI1 LDAA     XFER4
2871         BEQ     SERVI2
2872         CLR     XFER4
2873         BRA     BSERVK
2874 SERVI2 ORAB     #010H        I/O #4 BITE ERROR
2875         BRA     BSERVK
2876 SERVI3 LDAA     XMTRQ4      NO DATA AFTER TX REQ?
2877         BNE     SERVI1
2878 BSERVK STAB     BITELT
2879 ************************************************************
2880 *
2881 *       BEGIN SERVICING SYSTEM OUTPUT FIFO
2882 *
2883 SOF     LDAA    SOEN
2884         BEQ     SOF1
2885         BSR     SOFA
2886 SOF1    JMP     SIF
2887 *
2888 SOF2    LDX     OUTCHC      *TX SELF TEST ROUTINE*
2889         LDAB    #16
2890 SOF3    LDAA    DATA5       FIFO RDY?
2891         BMI     SOF5
2892         LDAA    #033H        OUTPUT TEST CHAR.
2893         STAA    PIA1BD
2894         DEX
2895         BNE     SOF4
2896         CLRA                DONE SELF TEST TX
2897         STAA    SOEN
2898         STAA    SELFTT
2899         STX     OUTCHC
```

```
2900          RTS
2901 SOF4     DECB
2902          BNE     SOF3
2903 SOF5     STX     OUTCHC
2904          RTS
2905 *
2906 SOFA     LDAA    SELFTT    TX SELF TEST?
2907          BNE     SOF2
2908          LDX     TXPNTR
2909          LDAA    DATA5     CHECK TX INHIBIT
2910          BITA    #1
2911          BEQ     SOFAA
2912          CLR     SOEN      TX INHIBIT: ABORT
2913          RTS
2914 SOFAA    LDX     2,X
2915          STX     TBPNTR
2916          LDX     TXPNTR
2917          LDX     4,X
2918          STX     TXCHCT
2919          LDX     TXPNTR
2920          LDX     14,X      SETUP L.G.D. PNTR FOR
2921          STX     TXLGDP    TX BURST SERVICE
2922          LDAA    GRP1FG
2923          BNE     SOFB
2924          JMP     SOFY
2925 SOFB     LDX     FILLCT
2926          LDAB    #0FFH      FILL PATTERN BEFORE DATA
2927          LDAA    DATA5     FIFO RDY? (DATA5-H=LOW)
2928          BPL     SOFBA
2929          STX     FILLCT
2930          RTS
2931 SOFBA    STAB    PIA1BD    OUTPUT FILL CHAR #1
2932          DEX
2933          BNE     SOFBB
2934          CLR     GRP1FG
2935          JMP     SOFD+2
2936 SOFBB    LDAA    DATA5     FIFO READY?
2937          BPL     SOFBC
2938          STX     FILLCT
2939          RTS
2940 SOFBC    STAB    PIA1BD    OUTPUT FILL CHAR #2
2941          DEX
2942          BNE     SOFBD
2943          CLR     GRP1FG
2944          JMP     SOFE+2
2945 SOFBD    LDAA    DATA5     FIFO READY?
2946          BPL     SOFBE
2947          STX     FILLCT
2948          RTS
2949 SOFBE    STAB    PIA1BD    OUTPUT FILL CHAR #3
2950          DEX
2951          BNE     SOFBF
2952          CLR     GRP1FG
2953          JMP     SOFF+2
2954 SOFBF    LDAA    DATA5     FIFO READY?
2955          BPL     SOFBG
2956          STX     FILLCT
```

```
2957         RTS
2958 SOFBG    STAB    PIA1BD    OUTPUT FILL CHAR #4
2959         DEX
2960         BNE     SOFBH
2961         CLR     GRP1FG
2962         JMP     SOFG+2
2963 SOFBH    LDAA    DATA5     FIFO READY?
2964         BPL     SOFBI
2965         STX     FILLCT
2966         RTS
2967 SOFBI    STAB    PIA1BD    OUTPUT FILL CHAR #5
2968         DEX
2969         BNE     SOFBJ
2970         CLR     GRP1FG
2971         JMP     SOFH+2
2972 SOFBJ    LDAA    DATA5     FIFO READY?
2973         BPL     SOFBK
2974         STX     FILLCT
2975         RTS
2976 SOFBK    STAB    PIA1BD    OUTPUT FILL CHAR #6
2977         DEX
2978         BNE     SOFBL
2979         CLR     GRP1FG
2980         JMP     SOFI+2
2981 SOFBL    LDAA    DATA5     FIFO READY?
2982         BPL     SOFBM
2983         STX     FILLCT
2984         RTS
2985 SOFBM    STAB    PIA1BD    OUTPUT FILL CHAR #7
2986         DEX
2987         BNE     SOFBN
2988         CLR     GRP1FG
2989         JMP     SOFJ+2
2990 SOFBN    LDAA    DATA5     FIFO READY?
2991         BPL     SOFBO
2992         STX     FILLCT
2993         RTS
2994 SOFBO    STAB    PIA1BD    OUTPUT FILL CHAR #8
2995         DEX
2996         BNE     SOFBP
2997         CLR     GRP1FG
2998         JMP     SOFK+2
2999 SOFBP    LDAA    DATA5     FIFO READY?
3000         BPL     SOFBQ
3001         STX     FILLCT
3002         RTS
3003 SOFBQ    STAB    PIA1BD    OUTPUT FILL CHAR #9
3004         DEX
3005         BNE     SOFBR
3006         CLR     GRP1FG
3007         JMP     SOFL+2
3008 SOFBR    LDAA    DATA5     FIFO READY?
3009         BPL     SOFBS
3010         STX     FILLCT
3011         RTS
3012 SOFBS    STAB    PIA1BD    OUTPUT FILL CHAR #10
3013         DEX
```

```
3014         BNE    SOFBT
3015         CLR    GRP1FG
3016         JMP    SOFM+2
3017 SOFBT   LDAA   DATA5    FIFO READY?
3018         BPL    SOFBU
3019         STX    FILLCT
3020         RTS
3021 SOFBU   STAB   PIA1BD   OUTPUT FILL CHAR #11
3022         DEX
3023         BNE    SOFBV
3024         CLR    GRP1FG
3025         JMP    SOFN+2
3026 SOFBV   LDAA   DATA5    FIFO READY?
3027         BPL    SOFBW
3028         STX    FILLCT
3029         RTS
3030 SOFBW   STAB   PIA1BD   OUTPUT FILL CHAR #12
3031         DEX
3032         BNE    SOFBX
3033         CLR    GRP1FG
3034         JMP    SOFO+2
3035 SOFBX   LDAA   DATA5    FIFO READY?
3036         BPL    SOFBY
3037         STX    FILLCT
3038         RTS
3039 SOFBY   STAB   PIA1BD   OUTPUT FILL CHAR #13
3040         DEX
3041         BNE    SOFBZ
3042         CLR    GRP1FG
3043         JMP    SOFP+2
3044 SOFBZ   LDAA   DATA5    FIFO READY?
3045         BPL    SOFB1
3046         STX    FILLCT
3047         RTS
3048 SOFB1   STAB   PIA1BD   OUTPUT FILL CHAR #14
3049         DEX
3050         BNE    SOFB2
3051         CLR    GRP1FG
3052         JMP    SOFQ+2
3053 SOFB2   LDAA   DATA5    FIFO READY?
3054         BPL    SOFB3
3055         STX    FILLCT
3056         RTS
3057 SOFB3   STAB   PIA1BD   OUTPUT FILL CHAR #15
3058         DEX
3059         BNE    SOFB4
3060         CLR    GRP1FG
3061         JMP    SOFR+2
3062 SOFB4   LDAA   DATA5    FIFO READY?
3063         BPL    SOFB5
3064         STX    FILLCT
3065         RTS
3066 SOFB5   STAB   PIA1BD   OUTPUT FILL CHAR #16
3067         DEX
3068         BNE    SOFB6
3069         CLR    GRP1FG
3070 SOFB6   STX    FILLCT
```

```
3071         RTS
3072 SOFC    LDAA    DATA5     FIFO READY?
3073         BPL     SOFCA
3074         JMP     SOFS
3075 SOFCA   LDX     TXCHCT
3076         BNE     SOFCB
3077         LDAA    #0FFH      GET STUFF CHAR
3078         STAA    TXEND
3079         LDX     TXPNTR
3080         STAA    13,X      SET PORT'S OUFG
3081         BRA     SOFCD
3082 SOFCB   DEX
3083         STX     TXCHCT
3084         LDX     TBPNTR
3085         LDAA    0,X       GET BUFF CHAR
3086         INX
3087         CPX     TXUVAL    ADJ BUFF PNTRS
3088         BNE     SOFCC
3089         LDX     TXLVAL
3090 SOFCC   STX     TBPNTR
3091         CPX     TXLGDP    LAST GOOD DATA?
3092         BNE     SOFCD
3093         LDX     #0        YES
3094         STX     TXLGDP
3095         STAB    TXDONE
3096 SOFCD   STAA    PIA1BD    OUTPUT CHAR #1
3097         LDX     OUTCHC
3098         DEX
3099         BNE     SOFD
3100         JMP     SOFT
3101 SOFD    STX     OUTCHC
3102         LDAA    DATA5     FIFO READY?
3103         BPL     SOFDA
3104         JMP     SOFS
3105 SOFDA   LDX     TXCHCT
3106         BNE     SOFDB
3107         LDAA    #0FFH      GET STUFF CHAR
3108         STAA    TXEND
3109         LDX     TXPNTR
3110         STAA    13,X
3111         BRA     SOFDD
3112 SOFDB   DEX
3113         STX     TXCHCT
3114         LDX     TBPNTR
3115         LDAA    0,X       GET BUFF CHAR
3116         INX
3117         CPX     TXUVAL    ADJ BUFF PNTRS
3118         BNE     SOFDC
3119         LDX     TXLVAL
3120 SOFDC   STX     TBPNTR
3121         CPX     TXLGDP    LAST GOOD DATA?
3122         BNE     SOFDD
3123         LDX     #0        YES
3124         STX     TXLGDP
3125         STAB    TXDONE
3126 SOFDD   STAA    PIA1BD    OUTPUT CHAR #2
3127         LDX     OUTCHC
```

```
3128         DEX
3129         BNE    SOFE
3130         JMP    SOFT
3131 SOFE    STX    OUTCHC
3132         LDAA   DATA5     FIFO READY?
3133         BPL    SOFEA
3134         JMP    SOFS
3135 SOFEA   LDX    TXCHCT
3136         BNE    SOFEB
3137         LDAA   #0FFH      GET STUFF CHAR
3138         STAA   TXEND
3139         LDX    TXPNTR
3140         STAA   13,X      SET PORT'S UOFG
3141         BRA    SOFED
3142 SOFEB   DEX
3143         STX    TXCHCT
3144         LDX    TBPNTR
3145         LDAA   0,X       GET BUFF CHAR
3146         INX
3147         CPX    TXUVAL    ADJ BUFF PNTRS
3148         BNE    SOFEC
3149         LDX    TXLVAL
3150 SOFEC   STX    TBPNTR
3151         CPX    TXLGDP    LAST GOOD DATA?
3152         BNE    SOFED
3153         LDX    #0        YES
3154         STX    TXLGDP
3155         STAB   TXDONE
3156 SOFED   STAA   PIA1BD    OUTPUT CHAR #3
3157         LDX    OUTCHC
3158         DEX
3159         BNE    SOFF
3160         JMP    SOFT
3161 SOFF    STX    OUTCHC
3162         LDAA   DATA5     FIFO READY?
3163         BPL    SOFFA
3164         JMP    SOFS
3165 SOFFA   LDX    TXCHCT
3166         BNE    SOFFB
3167         LDAA   #0FFH      GET STUFF CHAR
3168         STAA   TXEND
3169         LDX    TXPNTR
3170         STAA   13,X      SET PORT'S OUFG
3171         BRA    SOFFD
3172 SOFFB   DEX
3173         STX    TXCHCT
3174         LDX    TBPNTR
3175         LDAA   0,X       GET BUFF CHAR
3176         INX
3177         CPX    TXUVAL    ADJ BUFF PNTRS
3178         BNE    SOFFC
3179         LDX    TXLVAL
3180 SOFFC   STX    TBPNTR
3181         CPX    TXLGDP    LAST GOOD DATA?
3182         BNE    SOFFD
3183         LDX    #0        YES
3184         STX    TXLGDP
```

```
3185         STAB    TXDONE
3186 SOFFD   STAA    PIA1BD    OUTPUT CHAR #4
3187         LDX     OUTCHC
3188         DEX
3189         BNE     SOFG
3190         JMP     SOFT
3191 SOFG    STX     OUTCHC
3192         LDAA    DATA5     FIFO READY?
3193         BPL     SOFGA
3194         JMP     SOFS
3195 SOFGA   LDX     TXCHCT
3196         BNE     SOFGB
3197         LDAA    #0FFH      GET STUFF CHAR
3198         STAA    TXEND
3199         LDX     TXPNTR
3200         STAA    13,X      SET PORT'S OUFG
3201         BRA     SOFGD
3202 SOFGB   DEX
3203         STX     TXCHCT
3204         LDX     TBPNTR
3205         LDAA    0,X       GET BUFF CHAR
3206         INX
3207         CPX     TXUVAL    ADJ BUFF PNTRS
3208         BNE     SOFGC
3209         LDX     TXLVAL
3210 SOFGC   STX     TBPNTR
3211         CPX     TXLGDP    LAST GOOD DATA?
3212         BNE     SOFGD
3213         LDX     #0        YES
3214         STX     TXLGDP
3215         STAB    TXDONE
3216 SOFGD   STAA    PIA1BD    OUTPUT CHAR #5
3217         LDX     OUTCHC
3218         DEX
3219         BNE     SOFH
3220         JMP     SOFT
3221 SOFH    STX     OUTCHC
3222         LDAA    DATA5     FIFO READY?
3223         BPL     SOFHA
3224         JMP     SOFS
3225 SOFHA   LDX     TXCHCT
3226         BNE     SOFHB
3227         LDAA    #0FFH      GET STUFF CHAR
3228         STAA    TXEND
3229         LDX     TXPNTR
3230         STAA    13,X      SET PORT'S OUFG
3231         BRA     SOFHD
3232 SOFHB   DEX
3233         STX     TXCHCT
3234         LDX     TBPNTR
3235         LDAA    0,X       GET BUFF CHAR
3236         INX
3237         CPX     TXUVAL    ADJ BUFF PNTRS
3238         BNE     SOFHC
3239         LDX     TXLVAL
3240 SOFHC   STX     TBPNTR
3241         CPX     TXLGDP    LAST GOOD DATA?
```

```
3242         BNE    SOFHD
3243         LDX    #0        YES
3244         STX    TXLGDP
3245         STAB   TXDONE
3246 SOFHD   STAA   PIA1BD    OUTPUT CHAR #6
3247         LDX    OUTCHC
3248         DEX
3249         BNE    SOFI
3250         JMP    SOFT
3251 SOFI    STX    OUTCHC
3252         LDAA   DATA5     FIFO READY?
3253         BPL    SOFIA
3254         JMP    SOFS
3255 SOFIA   LDX    TXCHCT
3256         BNE    SOFIB
3257         LDAA   #0FFH      GET STUFF CHAR
3258         STAA   TXEND
3259         LDX    TXPNTR
3260         STAA   13,X      SET PORT'S OUFG
3261         BRA    SOFID
3262 SOFIB   DEX
3263         STX    TXCHCT
3264         LDX    TBPNTR
3265         LDAA   0,X       GET BUFF CHAR
3266         INX
3267         CPX    TXUVAL    ADJ BUFF PNTRS
3268         BNE    SOFIC
3269         LDX    TXLVAL
3270 SOFIC   STX    TBPNTR
3271         CPX    TXLGDP    LAST GOOD DATA?
3272         BNE    SOFID
3273         LDX    #0        YES
3274         STX    TXLGDP
3275         STAB   TXDONE
3276 SOFID   STAA   PIA1BD    OUTPUT CHAR #7
3277         LDX    OUTCHC
3278         DEX
3279         BNE    SOFJ
3280         JMP    SOFT
3281 SOFJ    STX    OUTCHC
3282         LDAA   DATA5     FIFO READY?
3283         BPL    SOFJA
3284         JMP    SOFS
3285 SOFJA   LDX    TXCHCT
3286         BNE    SOFJB
3287         LDAA   #0FFH      GET STUFF CHAR
3288         STAA   TXEND
3289         LDX    TXPNTR
3290         STAA   13,X      SET PORT'S OUFG
3291         BRA    SOFJD
3292 SOFJB   DEX
3293         STX    TXCHCT
3294         LDX    TBPNTR
3295         LDAA   0,X       GET BUFF CHAR
3296         INX
3297         CPX    TXUVAL    ADJ BUFF PNTRS
3298         BNE    SOFJC
```

```
3299         LDX    TXLVAL
3300 SOFJC   STX    TBPNTR
3301         CPX    TXLGDP   LAST GOOD DATA?
3302         BNE    SOFJD
3303         LDX    #0       YES
3304         STX    TXLGDP
3305         STAB   TXDONE
3306 SOFJD   STAA   PIA1BD   OUTPUT CHAR #8
3307         LDX    OUTCHC
3308         DEX
3309         BNE    SOFK
3310         JMP    SOFT
3311 SOFK    STX    OUTCHC
3312         LDAA   DATA5    FIFO READY?
3313         BPL    SOFKA
3314         JMP    SOFS
3315 SOFKA   LDX    TXCHCT
3316         BNE    SOFKB
3317         LDAA   #0FFH     GET STUFF CHAR
3318         STAA   TXEND
3319         LDX    TXPNTR
3320         STAA   13,X     SET PORT'S OUFG
3321         BRA    SOFKD
3322 SOFKB   DEX
3323         STX    TXCHCT
3324         LDX    TBPNTR
3325         LDAA   0,X      GET BUFF CHAR
3326         INX
3327         CPX    TXUVAL   ADJ BUFF PNTRS
3328         BNE    SOFKC
3329         LDX    TXLVAL
3330 SOFKC   STX    TBPNTR
3331         CPX    TXLGDP   LAST GOOD DATA?
3332         BNE    SOFKD
3333         LDX    #0       YES
3334         STX    TXLGDP
3335         STAB   TXDONE
3336 SOFKD   STAA   PIA1BD   OUTPUT CHAR #9
3337         LDX    OUTCHC
3338         DEX
3339         BNE    SOFL
3340         JMP    SOFT
3341 SOFL    STX    OUTCHC
3342         LDAA   DATA5    FIFO READY?
3343         BPL    SOFLA
3344         JMP    SOFS
3345 SOFLA   LDX    TXCHCT
3346         BNE    SOFLB
3347         LDAA   #0FFH     GET STUFF CHAR
3348         STAA   TXEND
3349         LDX    TXPNTR
3350         STAA   13,X     SET PORT'S OUFG
3351         BRA    SOFLD
3352 SOFLB   DEX
3353         STX    TXCHCT
3354         LDX    TBPNTR
3355         LDAA   0,X      GET BUFF CHAR
```

```
3356         INX
3357         CPX    TXUVAL   ADJ BUFF PNTRS
3358         BNE    SOFLC
3359         LDX    TXLVAL
3360 SOFLC   STX    TBPNTR
3361         CPX    TXLGDP   LAST GOOD DATA?
3362         BNE    SOFLD
3363         LDX    #0       YES
3364         STX    TXLGDP
3365         STAB   TXDONE
3366 SOFLD   STAA   PIA1BD   OUTPUT CHAR #10
3367         LDX    OUTCHC
3368         DEX
3369         BNE    SOFM
3370         JMP    SOFT
3371 SOFM    STX    OUTCHC
3372         LDAA   DATA5    FIFO READY?
3373         BPL    SOFMA
3374         JMP    SOFS
3375 SOFMA   LDX    TXCHCT
3376         BNE    SOFMB
3377         LDAA   #0FFH     GET STUFF CHAR
3378         STAA   TXEND
3379         LDX    TXPNTR
3380         STAA   13,X      SET PORT'S OUFG
3381         BRA    SOFMD
3382 SOFMB   DEX
3383         STX    TXCHCT
3384         LDX    TBPNTR
3385         LDAA   0,X       GET BUFF CHAR
3386         INX
3387         CPX    TXUVAL   ADJ BUFF PNTRS
3388         BNE    SOFMC
3389         LDX    TXLVAL
3390 SOFMC   STX    TBPNTR
3391         CPX    TXLGDP   LAST GOOD DATA?
3392         BNE    SOFMD
3393         LDX    #0       YES
3394         STX    TXLGDP
3395         STAB   TXDONE
3396 SOFMD   STAA   PIA1BD   OUTPUT CHAR #11
3397         LDX    OUTCHC
3398         DEX
3399         BNE    SOFN
3400         JMP    SOFT
3401 SOFN    STX    OUTCHC
3402         LDAA   DATA5    FIFO READY?
3403         BPL    SOFNA
3404         JMP    SOFS
3405 SOFNA   LDX    TXCHCT
3406         BNE    SOFNB
3407         LDAA   #0FFH     GET STUFF CHAR
3408         STAA   TXEND
3409         LDX    TXPNTR
3410         STAA   13,X      SET PORT' OUFG
3411         BRA    SOFND
3412 SOFNB   DEX
```

```
3413         STX     TXCHCT
3414         LDX     TBPNTR
3415         LDAA    0,X       GET BUFF CHAR
3416         INX
3417         CPX     TXUVAL    AND BUFF PNTRS
3418         BNE     SOFNC
3419         LDX     TXLVAL
3420 SOFNC   STX     TBPNTR
3421         CPX     TXLGDP    LAST GOOD DATA?
3422         BNE     SOFND
3423         LDX     #0        YES
3424         STX     TXLGDP
3425         STAB    TXDONE
3426 SOFND   STAA    PIA1BD    OUTPUT CHAR #12
3427         LDX     OUTCHC
3428         DEX
3429         BNE     SOFO
3430         JMP     SOFT
3431 SOFO    STX     OUTCHC
3432         LDAA    DATA5     FIFO READY?
3433         BPL     SOFOA
3434         JMP     SOFS
3435 SOFOA   LDX     TXCHCT
3436         BNE     SOFOB
3437         LDAA    #0FFH      GET STUFF CHAR
3438         STAA    TXEND
3439         LDX     TXPNTR
3440         STAA    13,X      SET PORT'S OUFG
3441         BRA     SOFOD
3442 SOFOB   DEX
3443         STX     TXCHCT
3444         LDX     TBPNTR
3445         LDAA    0,X       GET BUFF CHAR
3446         INX
3447         CPX     TXUVAL    ADJ BUFF PNTRS
3448         BNE     SOFOC
3449         LDX     TXLVAL
3450 SOFOC   STX     TBPNTR
3451         CPX     TXLGDP    LAST GOOD DATA?
3452         BNE     SOFOD
3453         LDX     #0        YES
3454         STX     TXLGDP
3455         STAB    TXDONE
3456 SOFOD   STAA    PIA1BD    OUTPUT CHAR #13
3457         LDX     OUTCHC
3458         DEX
3459         BNE     SOFP
3460         JMP     SOFT
3461 SOFP    STX     OUTCHC
3462         LDAA    DATA5     FIFO READY?
3463         BPL     SOFPA
3464         JMP     SOFS
3465 SOFPA   LDX     TXCHCT
3466         BNE     SOFPB
3467         LDAA    #0FFH      GET BUFF CHAR
3468         STAA    TXEND
3469         LDX     TXPNTR
```

```
3470          STAA    13,X      SET PORT'S OUFG
3471          BRA     SOFPD
3472 SOFPB    DEX
3473          STX     TXCHCT
3474          LDX     TBPNTR
3475          LDAA    0,X       GET BUF CHAR
3476          INX
3477          CPX     TXUVAL    ADJ BUFF PNTRS
3478          BNE     SOFPC
3479          LDX     TXLVAL
3480 SOFPC    STX     TBPNTR
3481          CPX     TXLGDP    LAST GOOD DATA?
3482          BNE     SOFPD
3483          LDX     #0        YES
3484          STX     TXLGDP
3485          STAB    TXDONE
3486 SOFPD    STAA    PIA1BD    OUTPUT CHAR #14
3487          LDX     OUTCHC
3488          DEX
3489          BNE     SOFQ
3490          JMP     SOFT
3491 SOFQ     STX     OUTCHC
3492          LDAA    DATA5     FIFO READY?
3493          BPL     SOFQA
3494          JMP     SOFS
3495 SOFQA    LDX     TXCHCT
3496          BNE     SOFQB
3497          LDAA    #0FFH      GET STUFF CHAR
3498          STAA    TXEND
3499          LDX     TXPNTR
3500          STAA    13,X      SET PORT'S OUFG
3501          BRA     SOFQD
3502 SOFQB    DEX
3503          STX     TXCHCT
3504          LDX     TBPNTR
3505          LDAA    0,X       GET BUFF CHAR
3506          INX
3507          CPX     TXUVAL    ADJ BUFF PNTRS
3508          BNE     SOFQC
3509          LDX     TXLVAL
3510 SOFQC    STX     TBPNTR
3511          CPX     TXLGDP    LAST GOOD DATA?
3512          BNE     SOFQD
3513          LDX     #0        YES
3514          STX     TXLGDP
3515          STAB    TXDONE
3516 SOFQD    STAA    PIA1BD    OUTPUT CHAR #15
3517          LDX     OUTCHC
3518          DEX
3519          BEQ     SOFT
3520 SOFR     STX     OUTCHC
3521          LDAA    DATA5     FIFO READY?
3522          BPL     SOFRA
3523          JMP     SOFS
3524 SOFRA    LDX     TXCHCT
3525          BNE     SOFRB
3526          LDAA    #0FFH      GET STUFF CHAR
```

```
3527         STAA   TXEND
3528         LDX    TXPNTR
3529         STAA   13,X      SET PORT'S OUFG
3530         BRA    SOFRD
3531 SOFRB   DEX
3532         STX    TXCHCT
3533         LDX    TBPNTR
3534         LDAA   0,X       GET BUFF CHAR
3535         INX
3536         CPX    TXUVAL    ADJ BUFF PNTRS
3537         BNE    SOFRC
3538         LDX    TXLVAL
3539 SOFRC   STX    TBPNTR
3540         CPX    TXLGDP    LAST GOOD DATA?
3541         BNE    SOFRD
3542         LDX    #0        YES
3543         STX    TXLGDP
3544         STAB   TXDONE
3545 SOFRD   STAA   PIA1BD    OUTPUT CHAR #16
3546         LDX    OUTCHC
3547         DEX
3548         BEQ    SOFT
3549         STX    OUTCHC
3550 SOFS    LDX    TXPNTR    STORE BUFF PNTRS
3551         LDAA   TXCHCT
3552         LDAB   TXCHCT+1
3553         STAA   4,X       RESTORE BUFF CHAR COUNT
3554         STAB   5,X
3555         LDAA   TBPNTR
3556         LDAB   TBPNTR+1
3557         STAA   2,X       RESTORE BUFF OUTPUT PNTR
3558         STAB   3,X
3559         LDAA   TXLGDP
3560         LDAB   TXLGDP+1
3561         STAA   14,X      RESTORE L.G.D. PNTR
3562         STAB   15,X
3563         RTS
3564 SOFT    LDAA   TXEND
3565         BEQ    SOFTB
3566 SOFTA   CLRB
3567         STAB   TXEND
3568         STAB   TXDONE
3569         STAB   TXCHCT
3570         STAB   TXCHCT+1
3571         LDAA   XMASK     CLR "DATA RDY PORT-"
3572         ANDA   PA1AD
3573         STAA   PA1AD
3574         STAA   PIA1AD
3575         LDX    TXPNTR
3576         STAB   8,X       CLR TX REQ FLAG
3577         STAB   13,X      CLR OUFG
3578         STAB   6,X       CLR EMPTY
3579         STAB   4,X       CLR CHCT
3580         STAB   5,X
3581         LDAB   #3
3582         STAB   7,X       SET FLBFG
3583         LDAA   MASKR     TX ACK OF I/O PORT
```

```
3584         ANDA   MRFTA    AND SET FIFO'S MR
3585         LDAB   XMASK
3586         COMB
3587         STAB   XMASK
3588         ORAA   XMASK
3589         STAA   MRFTA
3590         STAA   LATCH3
3591         BRA    SOFU
3592 SOFTB   LDAA   TXDONE
3593         BEQ    SOFU
3594         LDAA   XMASK    TEST PORT'S TX REQ INPUT
3595         COMA
3596         ANDA   DATA1
3597         BEQ    SOFTA
3598 SOFU    CLRA
3599         STAA   SOEN
3600         BRA    SOFS
3601 SOFY    LDAB   #0FFH
3602         LDAA   TXEND
3603         BNE    SOFYA
3604         LDAA   TXDONE
3605         BEQ    SOFYXX
3606         LDAA   XMASK    TEST PORT'S TX REQ INPUT
3607         COMA
3608         ANDA   DATA1
3609         BEQ    SOFYXX   BRANCH IF TX REQ = 0
3610         CLRA            GET HERE WITH MULTIPLE
3611         STAA   TXDONE   TX REQS. PER FRAME
3612 SOFYXX  JMP    SOFC
3613 SOFYA   LDX    OUTCHC
3614         LDAA   DATA5    FIFO RDY?
3615         BPL    SOFYA1
3616         RTS
3617 SOFYA1  STAB   PIA1BD   OUTPUT FILL CHAR #1
3618         DEX
3619         BEQ    SOFTA
3620 SOFYB   LDAA   DATA5    FIFO RDY?
3621         BPL    SOFYB1
3622         STX    OUTCHC
3623         RTS
3624 SOFYB1  STAB   PIA1BD   OUTPUT FILL CHAR #2
3625         DEX
3626         BEQ    SOFTA
3627 SOFYC   LDAA   DATA5    FIFO RDY?
3628         BPL    SOFYC1
3629         STX    OUTCHC
3630         RTS
3631 SOFYC1  STAB   PIA1BD   OUTPUT FILL CHAR #3
3632         DEX
3633         BNE    SOFYD
3634         JMP    SOFTA
3635 SOFYD   LDAA   DATA5    FIFO RDY?
3636         BPL    SOFYD1
3637         STX    OUTCHC
3638         RTS
3639 SOFYD1  STAB   PIA1BD   OUTPUT FILL CHAR #4
3640         DEX
```

```
3641         BNE    SOFYE
3642         JMP    SOFTA
3643 SOFYE   LDAA   DATA5    FIFO RDY?
3644         BPL    SOFYE1
3645         STX    OUTCHC
3646         RTS
3647 SOFYE1  STAB   PIA1BD   OUTPUT FILL CHAR #5
3648         DEX
3649         BNE    SOFYF
3650         JMP    SOFTA
3651 SOFYF   LDAA   DATA5    FIFO RDY?
3652         BPL    SOFYF1
3653         STX    OUTCHC
3654         RTS
3655 SOFYF1  STAB   PIA1BD   OUTPUT FILL CHAR #6
3656         DEX
3657         BNE    SOFYG
3658         JMP    SOFTA
3659 SOFYG   LDAA   DATA5    FIFO RDY?
3660         BPL    SOFYG1
3661         STX    OUTCHC
3662         RTS
3663 SOFYG1  STAB   PIA1BD   OUTPUT FILL CHAR #7
3664         DEX
3665         BNE    SOFYH
3666         JMP    SOFTA
3667 SOFYH   LDAA   DATA5    FIFO RDY?
3668         BPL    SOFYH1
3669         STX    OUTCHC
3670         RTS
3671 SOFYH1  STAB   PIA1BD   OUTPUT FILL CHAR #8
3672         DEX
3673         BNE    SOFYI
3674         JMP    SOFTA
3675 SOFYI   LDAA   DATA5    FIFO RDY?
3676         BPL    SOFYI1
3677         STX    OUTCHC
3678         RTS
3679 SOFYI1  STAB   PIA1BD   OUTPUT FILL CHAR #9
3680         DEX
3681         BNE    SOFYJ
3682         JMP    SOFTA
3683 SOFYJ   LDAA   DATA5    FIFO RDY?
3684         BPL    SOFYJ1
3685         STX    OUTCHC
3686         RTS
3687 SOFYJ1  STAB   PIA1BD   OUTPUT FILL CHAR #10
3688         DEX
3689         BNE    SOFYK
3690         JMP    SOFTA
3691 SOFYK   LDAA   DATA5    FIFO RDY?
3692         BPL    SOFYK1
3693         STX    OUTCHC
3694         RTS
3695 SOFYK1  STAB   PIA1BD   OUTPUT FILL CHAR #11
3696         DEX
3697         BNE    SOFYL
```

```
3698         JMP     SOFTA
3699 SOFYL   LDAA    DATA5     FIFO RDY?
3700         BPL     SOFYL1
3701         STX     OUTCHC
3702         RTS
3703 SOFYL1  STAB    PIA1BD    OUTPUT FILL CHAR #12
3704         DEX
3705         BNE     SOFYM
3706         JMP     SOFTA
3707 SOFYM   LDAA    DATA5     FIFO RDY?
3708         BPL     SOFYM1
3709         STX     OUTCHC
3710         RTS
3711 SOFYM1  STAB    PIA1BD    OUTPUT FILL CHAR #13
3712         DEX
3713         BNE     SOFYN
3714         JMP     SOFTA
3715 SOFYN   LDAA    DATA5     FIFO RDY?
3716         BPL     SOFYN1
3717         STX     OUTCHC
3718         RTS
3719 SOFYN1  STAB    PIA1BD    OUTPUT FILL CHAR #14
3720         DEX
3721         BNE     SOFYO
3722         JMP     SOFTA
3723 SOFYO   LDAA    DATA5     FIFO RDY?
3724         BPL     SOFYO1
3725         STX     OUTCHC
3726         RTS
3727 SOFYO1  STAB    PIA1BD    OUTPUT FILL CHAR #15
3728         DEX
3729         BNE     SOFYP
3730         JMP     SOFTA
3731 SOFYP   LDAA    DATA5     FIFO RDY?
3732         BPL     SOFYP1
3733         STX     OUTCHC
3734         RTS
3735 SOFYP1  STAB    PIA1BD    OUTPUT FILL CHAR #16
3736         DEX
3737         BNE     SOFYQ
3738         JMP     SOFTA
3739 SOFYQ   STX     OUTCHC
3740         RTS
3741 ************************************************************
3742 *
3743 *       BEGIN SERVICING SYSTEM INPUT FIFO
3744 *
3745 *
3746 SIF     LDAA    SIEN
3747         BNE     SIFA
3748         JMP     TDMA
3749 *
3750 SIF1    LDX     INCHC     *RX SELF TEST ROUTINE*
3751         LDAB    #16
3752 SIF2    LDAA    DATA1     CHAR IN RX FIFO?
3753         BPL     SIF6
3754         LDAA    DATA2     LOAD CHAR
```

```
3755         CMPA   #033H
3756         BEQ    SIF3      CORRECT CHARACTER?
3757         STAB   STERR
3758 SIF3    DEX
3759         BNE    SIF5
3760         CLRA
3761         STAA   SIEN
3762         STAA   SELFTR
3763         STX    INCHC
3764         LDAA   PA1AD
3765         LDAB   STERR
3766         BNE    SIF3A
3767         ANDA   #07FH      CLR DBP SELF TEST FAIL
3768         BRA    SIF4
3769 SIF3A   ORAA   #080H      SET DBP SELF TEST FAIL
3770 SIF4    STAA   PA1AD
3771         STAA   PIA1AD
3772         ANDA   #080H      ADJUST SELF TEST
3773         ORAA   BITELT     FAIL BITE LITE
3774         STAA   BITELT
3775         STAA   LATCH2
3776         CLR    STERR
3777         JMP    TDMA
3778 SIF5    DECB
3779         BNE    SIF2
3780 SIF6    STX    INCHC
3781         JMP    TDMA
3782 *
3783 SIFA    LDAA   SELFTR    RX SELF TEST?
3784         BNE    SIF1
3785         LDAA   INPTRC
3786         BEQ    SIFA1A
3787         LDX    RCRXPT
3788 SIFR    LDAA   DATA1     CHAR IN INPUT FIFO?
3789         BMI    SIFRA
3790 SIFR1   STX    RCRXPT
3791         JMP    TDMA
3792 SIFRA   LDAA   DATA2     LOAD & STORE FIFO CHAR
3793         STAA   0,X
3794         INX
3795         CPX    #ERCRX    BUFFER FULL?
3796         BNE    SIFR
3797         SEI
3798         LDX    #SRCRX
3799         LDAA   0,X
3800         STAA   ACIAD     LOAD ACIA WITH 1
3801         INX              R/CCOW RX CHARS.
3802         LDAA   #0BDH
3803         STAA   ACIACS
3804         STAA   TXIRFG
3805         STX    RCRXPT
3806         CLR    SIEN
3807         CLI
3808         JMP    TDMA
3809 ************************************************************
3810 *
3811 *FILL MISSING RX BURST WITH "FF" DATA
```

```
3812 *
3813 SIFRB  LDAB   #16      INIT STORE COUNTER
3814 SIFRC  LDAA   #0FFH
3815        LDX    RBPNTR
3816        STAA   0,X
3817        INX            ADJ PNTRS
3818        CPX    RXUVAL
3819        BNE    SIFRD
3820        LDX    RXLVAL
3821 SIFRD  STX    RBPNTR
3822        LDX    RBCHCT
3823        INX
3824        STX    RBCHCT
3825        LDX    INCHC   TEST FIFO CH CNT
3826        DEX
3827        BNE    SIFRE
3828        CLR    FILLFG
3829        JMP    SIFQ
3830 SIFRE  STX    INCHC
3831        DECB           DEC STORE COUNTER
3832        BNE    SIFRC
3833        JMP    SIFP
3834 *
3835 *
3836 SIFA1A LDX    RXPNTR  SETUP RCV PNTRS
3837        LDAA   8,X     TEST PORT'S TX REQ FLAG
3838        BNE    SIFA1C
3839        LDAA   PTONRX
3840        ANDA   MASKIO  TEST IF PORT IS ON
3841        BNE    SIFA1B
3842 SIFA1C CLR    SIEN    *ABORT RX BURST:  TX REQ*
3843        CLR    FILLFG  *OR PORT IS OFF*
3844        JMP    TDMA
3845 SIFA1B LDX    0,X
3846        STX    RBPNTR
3847        LDX    RXPNTR
3848        LDX    4,X
3849        STX    RBCHCT
3850        LDAA   FILLFG  FILL BURST WITH "FF"?
3851        BNE    SIFRB
3852        LDAA   DATA1
3853        BMI    SIFA1
3854        JMP    TDMA
3855 SIFA1  LDAA   DATA2   LOAD & STORE CHAR #1
3856        LDX    RBPNTR
3857        STAA   0,X
3858        INX            ADJ PNTRS
3859        CPX    RXUVAL
3860        BNE    SIFA2
3861        LDX    RXLVAL
3862 SIFA2  STX    RBPNTR
3863        LDX    RBCHCT
3864        INX
3865        STX    RBCHCT
3866        LDX    INCHC   TEST FIFO CH CNT
3867        DEX
3868        BNE    SIFB
```

```
3869         JMP     SIFQ
3870 SIFB    STX     INCHC
3871         LDAA    DATA1
3872         BMI     SIFB1
3873         JMP     SIFP
3874 SIFB1   LDAA    DATA2     LOAD & STORE FIFO CHAR #2
3875         LDX     RBPNTR
3876         STAA    0,X
3877         INX               ADJ PNTRS
3878         CPX     RXUVAL
3879         BNE     SIFB2
3880         LDX     RXLVAL
3881 SIFB2   STX     RBPNTR
3882         LDX     RBCHCT
3883         INX
3884         STX     RBCHCT
3885         LDX     INCHC     TEST FIFO CHAR COUNT
3886         DEX
3887         BNE     SIFC
3888         JMP     SIFQ
3889 SIFC    STX     INCHC
3890         LDAA    DATA1
3891         BMI     SIFC1
3892         JMP     SIFP
3893 SIFC1   LDAA    DATA2     LOAD & STORE FIFO CHAR #3
3894         LDX     RBPNTR
3895         STAA    0,X
3896         INX               ADJ PNTRS
3897         CPX     RXUVAL
3898         BNE     SIFC2
3899         LDX     RXLVAL
3900 SIFC2   STX     RBPNTR
3901         LDX     RBCHCT
3902         INX
3903         STX     RBCHCT
3904         LDX     INCHC     TEST FIFO CHAR COUNT
3905         DEX
3906         BNE     SIFD
3907         JMP     SIFQ
3908 SIFD    STX     INCHC
3909         LDAA    DATA1
3910         BMI     SIFD1
3911         JMP     SIFP
3912 SIFD1   LDAA    DATA2     LOAD & STORE FIFO CHAR #4
3913         LDX     RBPNTR
3914         STAA    0,X
3915         INX               ADJ PNTRS
3916         CPX     RXUVAL
3917         BNE     SIFD2
3918         LDX     RXLVAL
3919 SIFD2   STX     RBPNTR
3920         LDX     RBCHCT
3921         INX
3922         STX     RBCHCT
3923         LDX     INCHC     TEST FIFO CHAR COUNT
3924         DEX
3925         BNE     SIFE
```

```
3926         JMP     SIFQ
3927 SIFE    STX     INCHC
3928         LDAA    DATA1
3929         BMI     SIFE1
3930         JMP     SIFP
3931 SIFE1   LDAA    DATA2     LOAD & STORE FIFO CHAR #5
3932         LDX     RBPNTR
3933         STAA    0,X
3934         INX               ADJ PNTRS
3935         CPX     RXUVAL
3936         BNE     SIFE2
3937         LDX     RXLVAL
3938 SIFE2   STX     RBPNTR
3939         LDX     RBCHCT
3940         INX
3941         STX     RBCHCT
3942         LDX     INCHC     TEST FIFO CHAR COUNT
3943         DEX
3944         BNE     SIFF
3945         JMP     SIFQ
3946 SIFF    STX     INCHC
3947         LDAA    DATA1
3948         BMI     SIFF1
3949         JMP     SIFP
3950 SIFF1   LDAA    DATA2     LOAD & STORE FIFO CHAR #6
3951         LDX     RBPNTR
3952         STAA    0,X
3953         INX               ADJ PNTRS
3954         CPX     RXUVAL
3955         BNE     SIFF2
3956         LDX     RXLVAL
3957 SIFF2   STX     RBPNTR
3958         LDX     RBCHCT
3959         INX
3960         STX     RBCHCT
3961         LDX     INCHC     TEST FIFO CHAR COUNT
3962         DEX
3963         BNE     SIFG
3964         JMP     SIFQ
3965 SIFG    STX     INCHC
3966         LDAA    DATA1
3967         BMI     SIFG1
3968         JMP     SIFP
3969 SIFG1   LDAA    DATA2     LOAD & STORE FIFO CHAR #7
3970         LDX     RBPNTR
3971         STAA    0,X
3972         INX               ADJ PNTRS
3973         CPX     RXUVAL
3974         BNE     SIFG2
3975         LDX     RXLVAL
3976 SIFG2   STX     RBPNTR
3977         LDX     RBCHCT
3978         INX
3979         STX     RBCHCT
3980         LDX     INCHC     TEST FIFO CHAR COUNT
3981         DEX
3982         BNE     SIFH
```

```
3983         JMP    SIFQ
3984 SIFH    STX    INCHC
3985         LDAA   DATA1
3986         BMI    SIFH1
3987         JMP    SIFP
3988 SIFH1   LDAA   DATA2    LOAD & STORE FIFO CHAR #8
3989         LDX    RBPNTR
3990         STAA   0,X
3991         INX             ADJ PNTRS
3992         CPX    RXUVAL
3993         BNE    SIFH2
3994         LDX    RXLVAL
3995 SIFH2   STX    RBPNTR
3996         LDX    RBCHCT
3997         INX
3998         STX    RBCHCT
3999         LDX    INCHC    TEST FIFO CHAR COUNT
4000         DEX
4001         BNE    SIFI
4002         JMP    SIFQ
4003 SIFI    STX    INCHC
4004         LDAA   DATA1
4005         BMI    SIFI1
4006         JMP    SIFP
4007 SIFI1   LDAA   DATA2    LOAD & STORE FIFO CHAR #9
4008         LDX    RBPNTR
4009         STAA   0,X
4010         INX             ADJ PNTRS
4011         CPX    RXUVAL
4012         BNE    SIFI2
4013         LDX    RXLVAL
4014 SIFI2   STX    RBPNTR
4015         LDX    RBCHCT
4016         INX
4017         STX    RBCHCT
4018         LDX    INCHC    TEST FIFO CHAR COUNT
4019         DEX
4020         BNE    SIFX
4021         JMP    SIFQ
4022 SIFX    STX    INCHC
4023         LDAA   DATA1
4024         BMI    SIFX1
4025         JMP    SIFP
4026 SIFX1   LDAA   DATA2    LOAD & STORE FIFO CHAR #10
4027         LDX    RBPNTR
4028         STAA   0,X
4029         INX             ADJ PNTRS
4030         CPX    RXUVAL
4031         BNE    SIFX2
4032         LDX    RXLVAL
4033 SIFX2   STX    RBPNTR
4034         LDX    RBCHCT
4035         INX
4036         STX    RBCHCT
4037         LDX    INCHC    TEST FIFO CHAR COUNT
4038         DEX
4039         BNE    SIFJ
```

```
4040         JMP     SIFQ
4041 SIFJ    STX     INCHC
4042         LDAA    DATA1
4043         BMI     SIFJ1
4044         JMP     SIFP
4045 SIFJ1   LDAA    DATA2     LOAD & STORE FIFO CHAR #11
4046         LDX     RBPNTR
4047         STAA    0,X
4048         INX
4049         CPX     RXUVAL    ADJ PNTRS
4050         BNE     SIFJ2
4051         LDX     RXLVAL
4052 SIFJ2   STX     RBPNTR
4053         LDX     RBCHCT
4054         INX
4055         STX     RBCHCT
4056         LDX     INCHC     TEST FIFO CHAR COUNT
4057         DEX
4058         BNE     SIFK
4059         JMP     SIFQ
4060 SIFK    STX     INCHC
4061         LDAA    DATA1
4062         BMI     SIFK1
4063         JMP     SIFP
4064 SIFK1   LDAA    DATA2     LOAD & STORE FIFO CHAR #12
4065         LDX     RBPNTR
4066         STAA    0,X
4067         INX               ADJ PNTRS
4068         CPX     RXUVAL
4069         BNE     SIFK2
4070         LDX     RXLVAL
4071 SIFK2   STX     RBPNTR
4072         LDX     RBCHCT
4073         INX
4074         STX     RBCHCT
4075         LDX     INCHC     TEST FIFO CHAR COUNT
4076         DEX
4077         BNE     SIFL
4078         JMP     SIFQ
4079 SIFL    STX     INCHC
4080         LDAA    DATA1
4081         BMI     SIFL1
4082         JMP     SIFP
4083 SIFL1   LDAA    DATA2     LOAD & STORE FIFO CHAR #13
4084         LDX     RBPNTR
4085         STAA    0,X
4086         INX               ADJ PNTRS
4087         CPX     RXUVAL
4088         BNE     SIFL2
4089         LDX     RXLVAL
4090 SIFL2   STX     RBPNTR
4091         LDX     RBCHCT
4092         INX
4093         STX     RBCHCT
4094         LDX     INCHC     TEST FIFO CHAR COUNT
4095         DEX
4096         BNE     SIFM
```

```
4097          JMP     SIFQ
4098 SIFM     STX     INCHC
4099          LDAA    DATA1
4100          BPL     SIFP
4101 SIFM1    LDAA    DATA2     LOAD & STORE FIFO CHAR #14
4102          LDX     RBPNTR
4103          STAA    0,X
4104          INX               ADJ PNTRS
4105          CPX     RXUVAL
4106          BNE     SIFM2
4107          LDX     RXLVAL
4108 SIFM2    STX     RBPNTR
4109          LDX     RBCHCT
4110          INX
4111          STX     RBCHCT
4112          LDX     INCHC     TEST FIFO CHAR COUNT
4113          DEX
4114          BEQ     SIFQ
4115 SIFN     STX     INCHC
4116          LDAA    DATA1
4117          BPL     SIFP
4118 SIFN1    LDAA    DATA2     LOAD & STORE FIFO CHAR #15
4119          LDX     RBPNTR
4120          STAA    0,X
4121          INX               ADJ PNTRS
4122          CPX     RXUVAL
4123          BNE     SIFN2
4124          LDX     RXLVAL
4125 SIFN2    STX     RBPNTR
4126          LDX     RBCHCT
4127          INX
4128          STX     RBCHCT
4129          LDX     INCHC     TEST FIFO CHAR COUNT
4130          DEX
4131          BEQ     SIFQ
4132 SIFO     STX     INCHC
4133          LDAA    DATA1
4134          BPL     SIFP
4135 SIFO1    LDAA    DATA2     LOAD & STORE FIFO CHAR #16
4136          LDX     RBPNTR
4137          STAA    0,X
4138          INX               ADJ PNTRS
4139          CPX     RXUVAL
4140          BNE     SIFO2
4141          LDX     RXLVAL
4142 SIFO2    STX     RBPNTR
4143          LDX     RBCHCT
4144          INX
4145          STX     RBCHCT
4146          LDX     INCHC     TEST FIFO CHAR COUNT
4147          DEX
4148          BEQ     SIFQ
4149          STX     INCHC
4150 SIFP     LDX     RXPNTR    UPDATE PORT'S BUFF PNTRS.
4151          LDAA    RBCHCT
4152          LDAB    RBCHCT+1
4153          STAA    4,X
```

```
4154         STAB   5,X
4155         LDAA   RBPNTR
4156         LDAB   RBPNTR+1
4157         STAA   0,X
4158         STAB   1,X
4159         JMP    TDMA
4160 SIFQ    CLRA
4161         STAA   SIEN
4162         BRA    SIFP
4163 ************************************************************
4164 *
4165 *    INTERRUPT REQUEST SERVICE ROUTINE
4166 *
4167 *
4168 IRS      LDAB   ACIACS
4169         LDAA   TXIRFG
4170         BEQ    IRSC
4171         BITB   #2        TDR EMPTY?
4172         BEQ    IRSC
4173         LDX    RCRXPT
4174 IRSA     LDAA   0,X
4175         STAA   ACIAD     OUTPUT CHAR TO ACIA
4176         INX
4177         STX    RCRXPT
4178         CPX    #ERCRX
4179         BNE    IRSB
4180         LDAA   #09DH      CLR TX IRQ ENABLE
4181         STAA   ACIACS
4182         CLR    TXIRFG
4183 IRSB     BITB   #1        RDR FULL?
4184         BNE    IRSE
4185         RTI
4186 IRSC     BITB   #1
4187         BNE    IRSE
4188 IRSD     LDAA   #1        RCCOW/CCOW BITE ERROR:
4189         STAA   IRSBIT    IRQ ERROR OR SCU FORMAT ERR
4190         RTI
4191 IRSE     BITB   #070H      ACIA RX ERRORS?
4192         BEQ    IRSF
4193         LDAA   #1
4194         STAA   IRSBIT
4195 IRSF     LDAA   ACIAD     LOAD ACIA RX CHAR
4196         LDAB   RCFG
4197         BEQ    IRSJ
4198         DECB
4199         BEQ    IRSG
4200         DECB
4201         BNE    IRSN
4202         LDX    RTXPT
4203         STAA   0,X       STORE CHAR IN RCCOW BUFFER
4204         INX
4205         STX    RTXPT
4206         CPX    #ERTXB
4207         BNE    IRSI
4208         LDAA   #1        SET FOR RCCOW DATA READY
4209         STAA   RDRDY
4210         BRA    IRSH
```

```
4211 IRSG   LDX    CTXPT
4212        STAA   0,X       STORE CHAR IN CCOW BUFFER
4213        INX
4214        STX    CTXPT
4215        CPX    #ECTXB
4216        BNE    IRSI
4217        LDAA   #2        SET FOR CCOW DATA RDY
4218        STAA   CDRDY
4219 IRSH   CLR    RCFG
4220 IRSI   RTI
4221 IRSJ   CMPA   #0A3H
4222        BNE    IRSL
4223        LDX    #SCTXB
4224        STX    CTXPT
4225        LDAB   #1
4226 IRSK   STAB   RCFG
4227        RTI
4228 IRSL   CMPA   #0A4H
4229        BNE    IRSM
4230        LDX    #SRTXB
4231        STX    RTXPT
4232        LDAB   #2
4233        BRA    IRSK
4234 IRSM   CMPA   #0A9H
4235        BEQ    IRSMA
4236        CMPA   #0ABH                                          WBR
4237        BEQ    IRSMA                                          WBR
4238        BRA    IRSD                                           WBR
4239 IRSMA  TAB            GET RXINHB BIT 2 FROM A9/A11 BIT 2     WBR
4240        ANDB   #02H                                           WBR
4241        STAB   RXINHB                                         WBR
4242        LDAB   #3
4243        STAB   RC3FG
4244        BRA    IRSK
4245 IRSN   LDAB   RC3FG
4246        CMPB   #3
4247        BEQ    IRSQ
4248        CMPB   #2
4249        BEQ    IRSO
4250        TAB             GET RXINHB BITS 4,3 FROM BITS 7,6     WBR
4251        RORB                                                  WBR
4252        RORB                                                  WBR
4253        RORB                                                  WBR
4254        RORB                                                  WBR
4255        ANDB   #0CH                                           WBR
4256        ORAB   RXINHB                                         WBR
4257        STAB   RXINHB                                         SEF
4258        ANDA   #03FH     REMOVE RXINHB BITS BEFORE USING      WBR
4259        STAA   BRATE2    PORT BIT RATES (3 & 4)
4260        TAB
4261        ANDB   #7
4262        ANDA   #038H
4263        ASLB
4264        ASLB
4265        ASLB
4266        STAB   CHRAT3
4267        STAA   CHRAT4
```

```
4268        CLR    RCFG
4269        CLR    RC3FG
4270        RTI
4271 IRSO   TAB            GET RXINHB BIT 0 FROM BIT 6          WBR
4272        ROLB                                                WBR
4273        ROLB                                                WBR
4274        ROLB                                                WBR
4275        ANDB   #01H                                         WBR
4276        ORAB   RXINHB                                       WBR
4277        STAB   RXINHB                                       SEF
4278        ANDA   #0BFH    REMOVE RXINHB BIT BEFORE USING      WBR
4279        STAA   BRATE1   PORT BIT RATES (1 & 2)
4280        TAB
4281        ANDB   #080H                                        WBR
4282        STAB   BPS16K
4283        TAB
4284        ANDB   #7
4285        ANDA   #038H
4286        ASLB
4287        ASLB
4288        ASLB
4289        STAB   CHRAT1
4290        STAA   CHRAT2
4291 IRSP   DEC    RC3FG
4292        RTI
4293 IRSQ   STAA   PTONRX   PORT ON & RX ONLY INFO
4294        BRA    IRSP
4295 ************************************************************
4296 *
4297 * LOAD RX ELASTIC BUFFER FOR 16 KBPS
4298 *
4299 STUFF  LDX    #SBUFF1
4300        CLRB
4301 STUFA  STAA   0,X
4302        INX
4303        INCB
4304        BNE    STUFA
4305        RTS
4306 ************************************************************
4307 *
4308 INSERR BRA    INSERR   BAD INTERRUPT- CRASH
4309 *
4310 ************************************************************
4311 *
4312 * PROGRAM VERSION, ROM CHECKSUM VALUES, AND INTERRUPT VECTORS.
4313 *
4314 ************************************************************
4315        ORG     0FFF5H
4316 PGMVRS FCB     4         **PROGRAM VERSION**
4317 CKSMB  RMB     1         MSB OF CHECKSUM - BD. PROGRAMMER SUPPLIES VALUE
4318 CKSMA  RMB     1         LSB OF CHECKSUM - SEE 98-P08293T FOR DETAILS.
4319        FDB     IRS       IRQ VECTOR
4320        FDB     INSERR    SWI ERROR
4321        FDB     INSERR    NMI ERROR
4322        FDB     PWRON     RESTART VECTOR
4323 *
4324        END     PWRON
```

APPENDIX E

A. DATA BUFFER PROCESSOR LABEL CROSS REFERENCE

Label Name	Defined On	Referenced On
BITRAT	642	637 943
BSERV	2801	2351 2385 2406 2524 2528 2566 2580 2662 2684 2720 2740 2748 2757 2761 2765 2768 2771 2775 2779 2783 2787 2791
BSERVA	2806	2803
BSERVB	2821	2807
BSERVC	2826	2809
BSERVD	2832	
BSERVE	2833	2831 2835
BSERVF	2834	2829
BSERVG	2848	2843 2845
BSERVH	2858	2853 2855
BSERVI	2868	2863 2865
BSERVK	2878	2873 2875
CKSMA	4318	
CKSMB	4317	
CLEAR	116	29 126
CLEARA	118	120
INIT	68	11 175
INSERR	4308	4308
IO1A	1128	988
IO1A1	989	986
IO1A2	992	990
IO1A3	1025	1023
IO1AA	1132	1130
IO1B	1136	1134
IO1BA	1144	1147
IO1BB	1145	1143
IO1C	1148	1137 1139
IO1CA	1152	1141
IO1D	1160	1149 1314
IO1E	1164	1151
IO1F	1168	1166
IO1G	1200	1342
IO1H	1210	1161
IO1HA	1214	1212
IO1HB	1217	1215
IO1I	1221	1219 1284
IO1K	1226	1224

Label Name	Defined On	Referenced On							
IO1LF	1065	1387	1391	1395	1401	1405	1409	1413	1417
		1421	1425						
IO1LF1	1071	1068							
IO1LFA	1078	1073							
IO1LFB	1081	1075	1077	1079					
IO1LFC	1095	1085	1089						
IO1LFD	1102	1098							
IO1LS	1030	1221	1226	1231	1236	1244	1249	1254	1259
		1264	1269	1274					
IO1LSA	1053	1048							
IO1LSB	1056	1050	1052	1054					
IO1LSX	1047	1037							
IO1M	1231	1229							
IO1N10	1274	1272							
IO1N2	1236	1234							
IO1N3	1240	1238							
IO1N4	1244	1242							
IO1N5	1249	1247							
IO1N6	1254	1252							
IO1N7	1259	1257							
IO1N8	1264	1262							
IO1N9	1269	1267							
IO1O	1276	1216							
IO1P	1279								
IO1PT	984	712	729	739	778	816	854	927	932
		976							
IO1XP	1285	1220	1225	1230	1235	1239	1243	1248	1253
		1258	1263	1268	1273	1275	1278		
IO1XQ	1291	1286							
IO1Y	1292	1131	1135						
IO1YA	1314	1303	1316						
IO1YA1	1318	1213							
IO1YB	1315	1293							
IO1YC	1330								
IO1YC1	1338	1376	1384						
IO1YD	1343	1144	1317						
IO1YE	1350	1348							
IO1YE0	1369	1363	1373						
IO1YE1	1370	1101	1379						
IO1YF	1378	1344							
IO1YFA	1385	1382							
IO1YG	1387								
IO1YH	1391								
IO1Y1	1395								
IO1YJ	1398								

Label Name	Defined On	Referenced On
IO1YK	1401	
IO1YL	1405	
IO1YM	1409	
IO1YN	1413	
IO1YO	1417	
IO1YP	1421	
IO1YQ	1425	
IO2A	1574	1434
IO2A1	1435	1432
IO2A2	1438	1436
IO2A3	1471	1469
IO2AA	1578	1576
IO2B	1582	1580
IO2BA	1590	1593
IO2BB	1591	1589
IO2C	1594	1583 1585
IO2CA	1598	1587
IO2D	1606	1595 1771
IO2DA	1609	1607
IO2E	1611	1597
IO2F	1615	1613
IO2FA	1639	1634
IO2FB	1642	1638
IO2G	1653	1799
IO2GA	1657	1654
IO2GB	1658	1656
IO2H	1667	1608
IO2HA	1671	1669
IO2HB	1674	1672
IO2I	1678	1676 1741
IO2K	1683	1681
IO2LF	1511	1844 1848 1852 1858 1862 1866 1870 1874 1878 1882
IO2LF1	1517	1514
IO2LFA	1524	1519
IO2LFB	1527	1521 1523 1525
IO2LFC	1541	1531 1535
IO2LFD	1548	1544
IO2LS	1476	1678 1683 1688 1693 1701 1706 1711 1716 1721 1726 1731
IO2LSA	1499	1494
IO2LSB	1502	1496 1498 1500
IO2LSX	1493	1483
IO2M	1688	1686
IO2N10	1731	1729
IO2N2	1693	1691

Label Name	Defined On	Referenced On
IO2N3	1697	1695
IO2N4	1701	1699
IO2N5	1706	1704
IO2N6	1711	1709
IO2N7	1716	1714
IO2N8	1721	1719
IO2N9	1726	1724
IO2O	1733	1673
IO2P	1736	
IO2PT	1430	991 1025 1046 1163 1167 1199 1209 1291 1313 1349 1369 1377 1386 1390 1394 1397 1400 1404 1408 1412 1416 1420 1424
IO2XP	1742	1677 1682 1687 1692 1696 1700 1705 1710 1715 1720 1725 1730 1732 1735
IO2XQ	1748	1743
IO2Y	1749	1577 1581
IO2YA	1771	1760 1773
IO2YA1	1775	1670
IO2YB	1772	1750
IO2YC	1787	
IO2YC1	1795	1833 1841
IO2YD	1800	1590 1774
IO2YE	1807	1805
IO2YE0	1826	1820 1830
IO2YE1	1827	1547 1836
IO2YF	1835	1801
IO2YFA	1842	1839
IO2YG	1844	
IO2YH	1848	
IO2YI	1852	
IO2YJ	1855	
IO2YK	1858	
IO2YL	1862	
IO2YM	1866	
IO2YN	1870	
IO2YO	1874	
IO2YP	1878	
IO2YQ	1882	
IO3A	2031	1891
IO3A1	1892	1889
IO3A2	1895	1893
IO3A3	1928	1926
IO3AA	2035	2033
IO3B	2039	2037
IO3BA	2047	2050
IO3BB	2048	2046

Label Name	Defined On	Referenced On
IO3C	2051	2040 2042
IO3CA	2055	2044
IO3D	2063	2052 2228
IO3DA	2066	2064
IO3E	2068	2054
IO3F	2072	2070
IO3FA	2096	2091
IO3FB	2099	2095
IO3G	2110	2256
IO3GA	2114	2111
IO3GB	2115	2113
IO3H	2124	2065
IO3HA	2128	2126
IO3HB	2131	2129
IO3I	2135	2133 2198
IO3K	2140	2138
IO3LF	1968	2301 2305 2309 2315 2319 2323 2327 2331 2335 2339
IO3LF1	1974	1971
IO3LFA	1981	1976
IO3LFB	1984	1978 1980 1982
IO3LFC	1998	1988 1992
IO3LFD	2005	2001
IO3LS	1933	2135 2140 2145 2150 2158 2163 2168 2173 2178 2183 2188
IO3LSA	1956	1951
IO3LSB	1959	1953 1955 1957
IO3LSX	1950	1940
IO3M	2145	2143
IO3N10	2188	2186
IO3N2	2150	2148
IO3N3	2154	2152
IO3N4	2158	2156
IO3N5	2163	2161
IO3N6	2168	2166
IO3N7	2173	2171
IO3N8	2178	2176
IO3N9	2183	2181
IO3O	2190	2130
IO3P	2193	
IO3PT	1887	1437 1471 1492 1610 1614 1652 1666 1748 1770 1806 1826 1834 1843 1847 1851 1854 1857 1861 1865 1869 1873 1877 1881
IO3XP	2199	2134 2139 2144 2149 2153 2157 2162 2167 2172 2177 2182 2187 2189 2192
IO3XQ	2205	2200

Label Name	Defined On	Referenced On
IO3Y	2206	2034 2038
IO3YA	2228	2217 2230
IO3YAI	2232	2127
IO3YB	2229	2207
IO3YC	2244	
IO3YCI	2252	2290 2298
IO3YD	2257	2047 2231
IO3YE	2264	2262
IO3YE0	2283	2277 2287
IO3YE1	2284	2004 2293
IO3YF	2292	2258
IO3YFA	2299	2296
IO3YG	230I	
IO3YH	2305	
IO3YI	2309	
IO3YJ	2312	
IO3YK	2315	
IO3YL	2319	
IO3YM	2323	
IO3YN	2327	
IO3YO	233I	
IO3YP	2335	
IO3YQ	2339	
IO4A	2488	2348
IO4A1	2349	2346
IO4A2	2352	2350
IO4A3	2385	2383
IO4AA	2492	2490
IO4B	2496	2494
IO4BA	2504	2507
IO4BB	2505	2503
IO4C	2508	2497 2499
IO4CA	251I2	250I
IO4D	2520	2509 2685
IO4DA	2523	2521
IO4E	2525	2511
IO4F	2529	2527
IO4FA	2553	2548
IO4FB	2556	2552
IO4G	2567	2713
IO4GA	257I	2568
IO4GB	2572	2570
IO4H	2581	2522
IO4HA	2585	2583
IO4HB	2588	2586
IO4I	2592	2590 2655

Label Name	Defined On	Referenced On
IO4K	2597	2595
IO4LF	2425	2758 2762 2766 2772 2776 2780 2784 2788 2792 2795
IO4LF1	2431	2428
IO4LFA	2438	2433
IO4LFB	2441	2435 2437 2439
IO4LFC	2455	2445 2449
IO4LFD	2462	2458
IO4LS	2390	2592 2597 2602 2607 2615 2620 2625 2630 2635 2640 2645
IO4LSA	2413	2408
IO4LSB	2416	2410 2412 2414
IO4LSX	2407	2397
IO4M	2602	2600
IO4N10	2645	2643
IO4N2	2607	2605
IO4N3	2611	2609
IO4N4	2615	2613
IO4N5	2620	2618
IO4N6	2625	2623
IO4N7	2630	2628
IO4N8	2635	2633
IO4N9	2640	2638
IO4O	2647	2587
IO4P	2650	
IO4PT	2344	1894 1928 1949 2067 2071 2109 2123 2205 2227 2263 2283 2291 2300 2304 2308 2311 2314 2318 2322 2326 2330 2334 2338
IO4XP	2656	2591 2596 2601 2606 2610 2614 2619 2624 2629 2634 2639 2644 2646 2649
IO4XQ	2662	2657
IO4Y	2663	2491 2495
IO4YA	2685	2674 2687
IO4YA1	2689	2584
IO4YB	2686	2664
IO4YC	2701	
IO4YC1	2709	2747 2755
IO4YD	2714	2504 2688
IO4YE	2721	2719
IO4YE0	2740	2734 2744
IO4YE1	2741	2461 2750
IO4YF	2749	2715
IO4YFA	2756	2753
IO4YG	2758	
IO4YH	2762	
IO4YI	2766	

Label Name	Defined On	Referenced On
IO4YJ	2769	
IO4YK	2772	
IO4YL	2776	
IO4YM	2780	
IO4YN	2784	
IO4YO	2788	
IO4YP	2792	
IO4YQ	2795	
IRS	4168	
IRSA	4174	
IRSB	4183	4179
IRSC	4186	4170 4172
IRSD	4188	4238
IRSE	4191	4184 4187
IRSF	4195	4192
IRSG	4211	4199
IRSH	4219	4210
IRSI	4220	4207 4216
IRSJ	4221	4197
IRSK	4226	4233 4244
IRSL	4228	4222
IRSM	4234	4229
IRSMA	4239	4235 4237
IRSN	4245	4201
IRSO	4271	4249
IRSP	4291	4294
IRSQ	4293	4247
LD1	1107	1360 1361 1364 1365 1366 1367 1368
LD2	1553	1817 1818 1821 1822 1823 1824 1825
LD3	2010	2274 2275 2278 2279 2280 2281 2282
LD4	2467	2731 2732 2735 2736 2737 2738 2739
PGMVRS	4316	
PWRON	6	
PWRON1	58	30
RAMERR	31	19 34
RAMT	16	27
RAMTST	17	22
RBI	195	186 900
RBI1C	225	222
RBI1CA	228	226
RBI1D	232	230
RBI1DA	241	237
RBI1E	242	234
RBI1EA	252	247
RBI1G	264	245

Label Name	Defined On	Referenced On
RBI1GA	271	
RBI1GB	284	278
RBI1H	293	266 283
RBI1H1	294	263
RBI1HA	303	297
RBI1HB	307	302
RBI2B	313	223
RBI2C	316	314
RBI2CA	319	317
RBI2D	323	321
RBI2DA	332	328
RBI2E	333	325
RBI2EA	343	338
RBI2G	355	336
RBI2GA	362	
RBI2GB	377	369
RBI2H	386	357 376
RBI2H1	387	354
RBI2HA	396	390
RBI2HB	400	395
RBI3B	406	315
RBI3C	409	407
RBI3CA	412	410
RBI3D	416	414
RBI3DA	425	421
RBI3E	426	418
RBI3EA	436	431
RBI3G	448	429
RBI3GA	455	
RBI3GB	470	462
RBI3H	479	450 469
RBI3H1	480	447
RBI3HA	489	483
RBI3HB	493	488
RBI4B	499	408
RBI4C	502	500
RBI4CA	505	503
RBI4D	509	507
RBI4DA	518	514
RBI4E	519	511
RBI4EA	529	524
RBI4G	541	522
RBI4GA	548	
RBI4GB	563	555
RBI4H	572	543 562

Label Name	Defined On	Referenced On
RBI4H1	573	540
RBI4HA	582	576
RBI4HB	586	581
RBIA	198	196
RBIB	210	199
RBIBA	217	213
RBIJ	594	501
RBIJA	600	595
RBIK	610	602
RBIKA	616	634
RBIL	619	614
RBIM	625	636
RBIN	631	612
RBIO	635	632
RBIS	637	311 404 497 590
RBISA	651	647
RBISB	656	652
RBISC	661	657
RBISD	666	662
RBISE	671	667
RBISF	674	643
RBIT	683	599 638
RBIU	677	645
ROMERR	53	48 50 56
ROMTSA	41	46
ROMTST	38	28
SERVF1	2840	2847
SERVF2	2844	2841
SERVF3	2846	2839
SERVG1	2850	2857
SERVG2	2854	2851
SERVG3	2856	2849
SERVH1	2860	2867
SERVH2	2864	2861
SERVH3	2866	2859
SERVI1	2870	2877
SERVI2	2874	2871
SERVI3	2876	2869
SETUP	126	
SETUP1	127	58 188
SETUP3	152	141
SIF	3746	2886
SIF1	3750	3784
SIF2	3752	3779
SIF3	3758	3756

Label Name	Defined On	Referenced On
SIF3A	3769	3766
SIF4	3770	3768
SIF5	3778	3759
SIF6	3780	3753
SIFA	3783	3747
SIFA1	3855	3853
SIFA1A	3836	3786
SIFA1B	3845	3841
SIFA1C	3842	3838
SIFA2	3862	3860
SIFB	3870	3868
SIFB1	3874	3872
SIFB2	3881	3879
SIFC	3889	3887
SIFC1	3893	3891
SIFC2	3900	3898
SIFD	3908	3906
SIFD1	3912	3910
SIFD2	3919	3917
SIFE	3927	3925
SIFE1	3931	3929
SIFE2	3938	3936
SIFF	3946	3944
SIFF1	3950	3948
SIFF2	3957	3955
SIFG	3965	3963
SIFG1	3969	3967
SIFG2	3976	3974
SIFH	3984	3982
SIFH1	3988	3986
SIFH2	3995	3993
SIFI	4003	4001
SIFI1	4007	4005
SIFI2	4014	4012
SIFJ	4041	4039
SIFJ1	4045	4043
SIFJ2	4052	4050
SIFK	4060	4058
SIFK1	4064	4062
SIFK2	4071	4069
SIFL	4079	4077
SIFL1	4083	4081
SIFL2	4090	4088
SIFM	4098	4096
SIFM1	4101	

Label Name	Defined On	Referenced On
SIFM2	4108	4106
SIFN	4115	
SIFN1	4118	
SIFN2	4125	4123
SIFO	4132	
SIFO1	4135	
SIFO2	4142	4140
SIFP	4150	3833 3873 3892 3911 3930 3949 3968 3987 4006 4025 4044 4063 4082 4100 4117 4134 4162
SIFQ	4160	3829 3869 3888 3907 3926 3945 3964 3983 4002 4021 4040 4059 4078 4097 4114 4131 4148
SIFR	3788	3796
SIFR1	3790	
SIFRA	3792	3789
SIFRB	3813	3851
SIFRC	3814	3832
SIFRD	3821	3819
SIFRE	3830	3827
SIFX	4022	4020
SIFX1	4026	4024
SIFX2	4033	4031
SOF	2883	2833
SOF1	2886	2884
SOF2	2888	2907
SOF3	2890	2902
SOF4	2901	2895
SOF5	2903	2891
SOFA	2906	2885
SOFAA	2914	979 2911
SOFB	2925	2923
SOFB1	3048	3045
SOFB2	3053	3050
SOFB3	3057	3054
SOFB4	3062	3059
SOFB5	3066	3063
SOFB6	3070	3068
SOFBA	2931	2928
SOFBB	2936	2933
SOFBC	2940	2937
SOFBD	2945	2942
SOFBE	2949	2946
SOFBF	2954	2951
SOFBG	2958	2955

Label Name	Defined On	Referenced On
SOFBH	2963	2960
SOFBI	2967	2964
SOFBJ	2972	2969
SOFBK	2976	2973
SOFBL	2981	2978
SOFBM	2985	2982
SOFBN	2990	2987
SOFBO	2994	2991
SOFBP	2999	2996
SOFBQ	3003	3000
SOFBR	3008	3005
SOFBS	3012	3009
SOFBT	3017	3014
SOFBU	3021	3018
SOFBV	3026	3023
SOFBW	3030	3027
SOFBX	3035	3032
SOFBY	3039	3036
SOFBZ	3044	3041
SOFC	3072	3612
SOFCA	3075	3073
SOFCB	3082	3076
SOFCC	3090	3088
SOFCD	3096	3081 3092
SOFD	3101	3099
SOFDA	3105	3103
SOFDB	3112	3106
SOFDC	3120	3118
SOFDD	3126	3111 3122
SOFE	3131	3129
SOFEA	3135	3133
SOFEB	3142	3136
SOFEC	3150	3148
SOFED	3156	3141 3152
SOFF	3161	3159
SOFFA	3165	3163
SOFFB	3172	3166
SOFFC	3180	3178
SOFFD	3186	3171 3182
SOFG	3191	3189
SOFGA	3195	3193
SOFGB	3202	3196
SOFGC	3210	3208
SOFGD	3216	3201 3212
SOFH	3221	3219

Label Name	Defined On	Referenced On
SOFHA	3225	3223
SOFHB	3232	3226
SOFHC	3240	3238
SOFHD	3246	3231 3242
SOFI	3251	3249
SOFIA	3255	3253
SOFIB	3262	3256
SOFIC	3270	3268
SOFID	3276	3261 3272
SOFJ	3281	3279
SOFJA	3285	3283
SOFJB	3292	3286
SOFJC	3300	3298
SOFJD	3306	3291 3302
SOFK	3311	3309
SOFKA	3315	3313
SOFKB	3322	3316
SOFKC	3330	3328
SOFKD	3336	3321 3332
SOFL	3341	3339
SOFLA	3345	3343
SOFLB	3352	3346
SOFLC	3360	3358
SOFLD	3366	3351 3362
SOFM	3371	3369
SOFMA	3375	3373
SOFMB	3382	3376
SOFMC	3390	3388
SOFMD	3396	3381 3392
SOFN	3401	3399
SOFNA	3405	3403
SOFNB	3412	3406
SOFNC	3420	3418
SOFND	3426	3411 3422
SOFO	3431	3429
SOFOA	3435	3433
SOFOB	3442	3436
SOFOC	3450	3448
SOFOD	3456	3441 3452
SOFP	3461	3459
SOFPA	3465	3463
SOFPB	3472	3466
SOFPC	3480	3478
SOFPD	3486	3471 3482
SOFQ	3491	3489

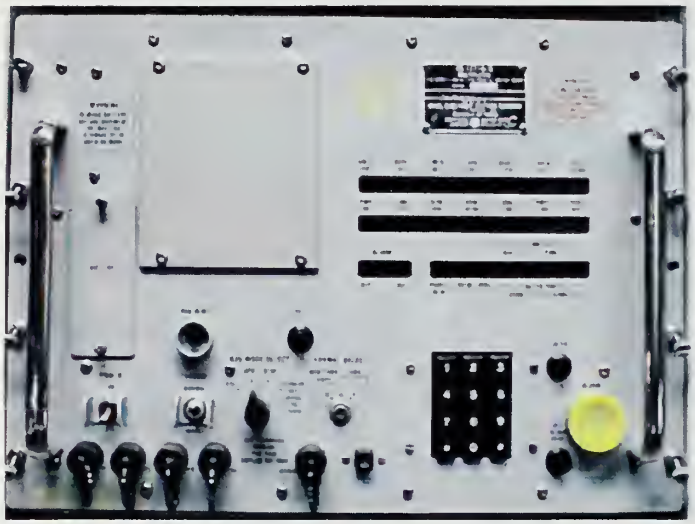
Label Name	Defined On	Referenced On
SOFQA	3495	3493
SOFQB	3502	3496
SOFQC	3510	3508
SOFQD	3516	3501 3512
SOFR	3520	
SOFRA	3524	3522
SOFRB	3531	3525
SOFRC	3539	3537
SOFRD	3545	3530 3541
SOFS	3550	3074 3104 3134 3164 3194 3224 3254 3284 3314 3344 3374 3404 3434 3464 3494 3523 3600
SOFT	3564	3100 3130 3160 3190 3220 3250 3280 3310 3340 3370 3400 3430 3460 3490 3519 3548
SOFTA	3566	3597 3619 3626 3634 3642 3650 3658 3666 3674 3682 3690 3698 3706 3714 3722 3730 3738
SOFTB	3592	3565
SOFU	3598	3591 3593
SOFY	3601	2924
SOFYA	3613	3603
SOFYA1	3617	3615
SOFYB	3620	
SOFYB1	3624	3621
SOFYC	3627	
SOFYC1	3631	3628
SOFYD	3635	3633
SOFYD1	3639	3636
SOFYE	3643	3641
SOFYE1	3647	3644
SOFYF	3651	3649
SOFYF1	3655	3652
SOFYG	3659	3657
SOFYG1	3663	3660
SOFYH	3667	3665
SOFYH1	3671	3668
SOFYI	3675	3673
SOFYI1	3679	3676
SOFYJ	3683	3681
SOFYJ1	3687	3684
SOFYK	3691	3689
SOFYK1	3695	3692
SOFYL	3699	3697
SOFYL1	3703	3700
SOFYM	3707	3705

Label Name	Defined On	Referenced On
SOFYM1	3711	3708
SOFYN	3715	3713
SOFYN1	3719	3716
SOFYO	3723	3721
SOFYO1	3727	3724
SOFYP	3731	3729
SOFYP1	3735	3732
SOFYQ	3739	3737
SOFYXX	3612	3605 3609
STUFA	4301	4304
STUFF	4299	279 370 463 556
TBI	692	197 227 231 251 318 322 342 411 415 435 504 508 528 617 630
TBI1	698	693
TBI1BA	741	738
TBI1E	748	742
TBI1EA	752	747
TBI1F	768	766
TBI2	703	697
TBI2B	773	735
TBI2BA	779	777
TBI2E	786	780
TBI2EA	790	785
TBI2F	806	804
TBI3	705	699
TBI3B	811	774
TBI3BA	817	815
TBI3E	824	818
TBI3EA	828	823
TBI3F	844	842
TBI4	710	706
TBI4B	849	812
TBI4BA	855	853
TBI4E	862	856
TBI4EA	866	861
TBI4F	882	880
TBIA	713	711
TBIB	721	714
TBIBA	730	728
TBIG	887	730 850
TBIG1	897	899
TBIGA	901	888
TBIGB	908	910
TBIGC	912	905
TBIH	914	918

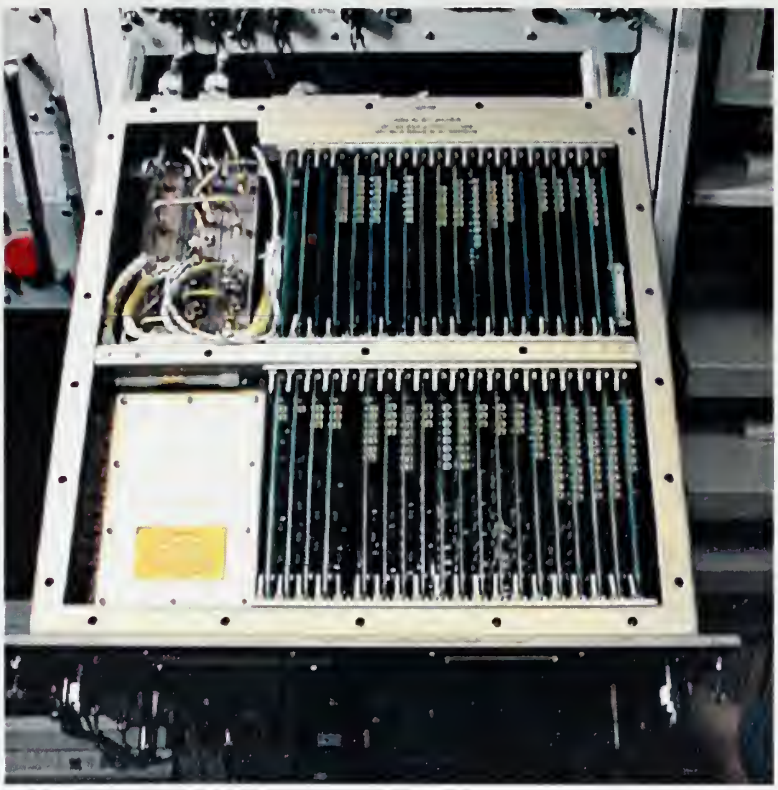
Label Name	Defined On	Referenced On
TBIHA	921	942
TBIHB	925	911
TBIHC	928	926
TBIJ	933	902
TBIK	935	939
TBIN	943	771 809 847 885
TBIO	944	
TBIQ	949	
TBIQ1	952	
TBIR	962	958
TBIRA	964	959 961
TBIRB	977	970
TBIS	979	951 963
TDMA	156	64 172 183 3748 3777 3781 3791 3808 3844 3854 4159
TDMA1	185	159
TDMAA	170	167
TDMAB	171	169
TDMAI	174	161
TIBA	731	725
TSTROM	28	24

APPENDIX F

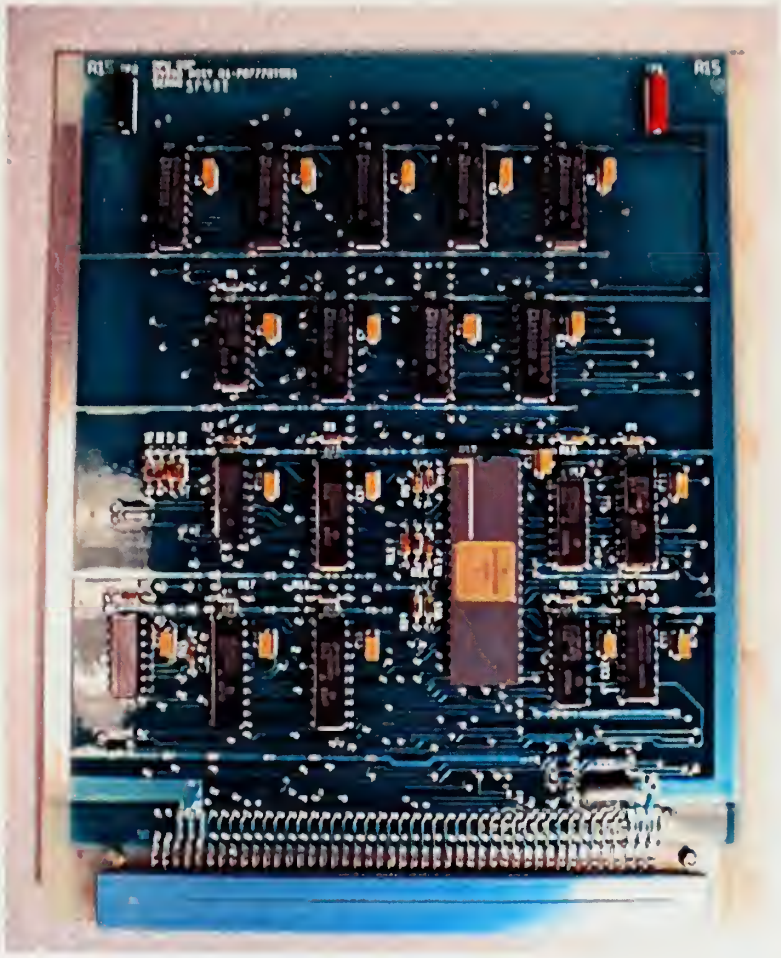
A. PHOTOS



TD-1271B/U Front Panel



TD-1271B/U Card Cage



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